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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Why "Mild" Steel Castings?

Though specifications do not emphasise the fact, the most important feature of any casting must be that it is of the required shape and size, and the second and still fundamental feature is soundness. Obviously unless a casting can reasonably fulfil these requirements, it is useless. The imposition of specifications, often of an unsuitable character, has frequently modified foundry practice by compelling the manufacturer to meet imposed tests rather than commonsense ones. In no branch of foundry practice has this been more felt than in the manufacture of light steel castings. We believe most melters would agree that the lower the carbon, the more difficult the steel is to "kill," or, in other words, render sound. Then again, the lower the carbon the higher the melting point, and the further the melting point is removed from shop temperature, the greater the amount of superheat necessary to run the thin sections associated with this branch of the industry. With every increase in temperature there is associated greater moulding difficulties, for the sand must be more refractory and must lend itself more to contraction pulls. Thus we come to the question asked in the title: Why *mild* steel castings? Its only advantages are increased ductility, it may or may not bend through 90 deg. without breaking, and it will machine easily. Its disadvantages are increased liability to the numerous casting defects to which all metals are heir. To illustrate clearly what is happening regularly in the light steel castings industry, we give as an example the case of a special valve casting, the making of which was unsuccessfully attempted by numerous firms. They were all in a position to submit test bars capable of meeting any of the usual specifications, *but they could not make a watertight casting.* In desperation, the purchasing firm called in a well-known consulting metallurgist, who suggested that the casting should be made in medium carbon steel, and the trouble immediately disappeared. We suggest that the time is now ripe for steel foundrymen to drop the *mild* steel casting fetish. It is ridiculous to save machining costs if a distinct uncertainty exists as to whether the casting is sound. We reiterate the axiom expressed on opening this article, *first make sound castings.* If this involves the alteration of specifications, then the steel foundries must co-operate to have them modified. If they shout sufficiently loudly, this will be done. If really mild steel is necessary for some jobs, then the purchaser should pay extra for it, especially if he thinks he can save money in the machine shop. Railway tyres containing 0.5 per cent. chromium are machined at high speeds with fairly heavy cuts and traverse, so the steel we advocate should offer but little difficulty to the smart machine-shop manager. We fail entirely to visualise the serious commercial advantages of castings which will bend double before fracture, but we are cognisant of many jobs, where cast iron will not quite "fill the bill," but a *sound* 0.50 per cent. carbon steel would do all that is required. We assert in no indefinite manner that it is high time that this question was taken up nationally, as it would lower production costs, seriously reduce waster losses, and improve delivery during the busy periods. It might further do much to meet the extensive foreign competition which exists in this section of foundry work.

Digressing for a moment, we would point out that it is highly probable that cast-iron founders will be called upon, in the near future, regularly to meet some simple static tests, and we would warn them in advance not to lose sight of the main object of their business, which is the production of sound castings and not the meeting of specifications. These should be designed to provide an easy minimum mechanical standard, but not to control or override commonsense desiderata.

Previously we have pleaded for the formation of a British light steel-castings research association, and now we would point out that unless an effort is made in the near future, there will probably be a difficulty in obtaining any monetary support from the Government. This industry is far too prone to hang on to the steel ingot industry instead of carving out a definite sphere for themselves.

Electric Heating for Industrial Purposes.

By H. M. Drake.*

Introductory.

No doubt the slow development of electric industrial heating in this country is due to the comparatively high cost of current, which has discouraged manufacturers from its adoption. When, however, one sees what enormous improvements have been made in America during the last few years in the design and efficiency of the furnaces used and thereby in the various products, one begins to realise that England, if she is to keep her place in world trade, must fall into line.

Applications.

The first question which naturally arises is the type of process which can be done better by electricity than by other methods. This includes all operations requiring temperatures not exceeding 1,050 deg. C., in which close control and uniformity of temperature are of importance. In the category are the following:—All kinds of heat treatment of steel (annealing, hardening, tempering); annealing wire; shrinking guns; baking japan and paint; baking vitreous enamel; baking cores; annealing glass, and sheradising, etc.

Costs.

The next question is one of cost both of the original installation and of operation. It must be admitted at once that the first cost would appear comparatively high and that the actual cost of heat units produced is usually larger than for other types of furnace, but when the total overall cost is taken into consideration and other factors are considered, the case for electricity becomes very strong.

Labour.

In these days the question of labour is a serious one both with respect to expense and skill. The writer inspected a factory in America where two men are working an electric furnace, which has a larger output than was formerly obtained by the eight men necessary for the operation of the old furnace. This is due partly to the fact that the temperature control is entirely automatic and partly because electric heating facilitates the use of other labour saving devices both in the loading and operation of the furnace.

Automatic Temperature Control.

The automatic control mentioned above not only reduces the human element to a minimum and enables unskilled men at low piece work rates to earn more money on an electric furnace than skilled men at higher rates on other furnaces, but it is so accurate that a variation of 1.5 deg. C. plus or minus is obtainable even when working at temperatures as high as 980 deg. C.

Uniformity of Temperature.

The small variation at any given time in the temperature at different parts of the furnace, which is seldom greater than 3 deg. C., plus or minus, is of enormous value in the heat treatment of steel, thus enabling the metallurgist to maintain a given temperature throughout the steel which he is treating without the necessity of going to a higher temperature to make sure that the under portions have been properly heated. This uniformity of temperature is partly due to the fact that the heating units are never more than 55 deg. C. hotter than the charge of the furnace when soaking temperature has been reached, and partly because the heat supplied by the heating units is transmitted mainly by radiation and not by convection currents, as in combusion furnaces.

Thermal Efficiency.

It has been found that the heating cycle can usually be shortened considerably, and that the maximum temperature necessary for a given result is much lower in electric furnaces than in other types. This is due largely to the causes already mentioned, but the high thermal efficiency obtainable is also responsible. The low temperature of the heating units as compared with that of a flame makes efficient heat insulation an easier problem, so that radiation losses from the furnace itself are almost negligible. The absence of combustion dispenses with the necessity of a chimney, which has always hitherto carried off much useful heat even in furnaces where the most modern recuperative design has been utilised.

Improved Product.

The absence of combustion is important from another point of view also as it enables any desired atmosphere to be maintained in the furnace. In the case of steel this minimises the formation of "scale," and in cases where metal containers are necessary, their life is materially prolonged and in some cases they can be dispensed with altogether.

In vitreous enamelling no staining is experienced, due to the presence of sulphur or other deleterious matter in the coal and in glass annealing the ware comes out of the lehr perfectly clean and sterile, and the necessity of washing is eliminated. The accuracy of control and uniformity of temperature yield a product which is infinitely superior, and often enable operations to be performed which have formerly been found impossible. This is especially true in the vitreous enamelling trade, where it was very difficult to obtain the necessary temperature near the middle of certain types of ware without the enamel running at the outside which was near the walls of the furnace.

Reduction of Wasters.

It is, therefore, rare to find any material spoilt in the furnace owing to unequal heating, overheating, undue sealing, staining by flue gases or other causes. Thus a large saving is effected in any process where the furnace is responsible for the last phase, as is the case with japanning and vitreous enamelling; the cost of all spoilt material must be added to the price of the finished saleable article, and in many cases a comparatively small reduction of "wasters" more than pays for any extra cost of heating. The same argument applies to glass annealing lehres, where breakages have been reduced by 25 per cent. owing to the fact that internal strains are reduced to a degree hitherto unknown.

Construction.

The design of a furnace depends, of course, upon the type of work for which is is intended, but in general it may be considered as a box with a firebrick lining into which are built refractory hanger blocks on which resistors made of a nickel-chromium alloy are suspended. The firebrick is surrounded by efficient heat insulating material, and the whole is enclosed in steel sheeting and suitably reinforced. This fundamental construction allows many variations, and furnaces are built of the following types:—(1) Multiple type with one door; (2) tunnel type with a door at each end: (3) car-bottom type with one or two doors; (4) vertical pit type; (5) conveyor type; (6) rotary type: (7) recuperative type in which the hot out-going work gives up most of its heat to the cold in-coming work, thereby pre-heating the latter.

Other designs have been built to suit special requirements, but the above list covers the types mostly in use.

Low Maintenance.

The two main causes of the low maintenance costs are:—(1) The low temperature of the resistors compared with that of the flame. (2) The simple strong design as opposed to the flues, ports, dampers and muffles inherent in the design of fuel fired furnaces.

It may be said that both the refractory and the resistors last practically for ever; in fact, careful measurements made after two years' continuous operation disclosed no trace of alteration in size, composition or weight of the resistors.

Space Occupied.

The electric furnace entirely dispenses with the necessity for fuel storage, and much space is thereby saved apart from the plant necessary for its handling and the incidental labour. Except in the few cases where transformers are necessary, the small control board is the only accessory to the furnace, which is itself very compact, so that considerable saving in buildings, etc., can be effected.

* The Author is a Director of Messrs. Drake & Gorham, Ltd., Electric Furnace Specialists, of 36, Grosvenor Gardens, London, S.W.

Programme of Tour of American Foundrymen.

The programme detailed below is of a tentative character, and slight changes are possible, but it is substantially accurate.

Saturday, August 18.—Leave New York in s.s. "Leviathan."

Friday, August 24.—Arrive Southampton, proceeding immediately to London *viâ* special boat train.

Saturday, August 25.—Trip by motor car to Windsor, inspection of the Castle, and tea.

Monday, August 27.—Visit to the propeller foundry of Messrs. J. Stone & Company, Limited, of Deptford. Entertainment in the evening to which all members of the American delegation will be invited by the London Branch of the Institute of British Foundrymen and the Iron and Steel Institute.

Tuesday, August 28.—3.30 p.m. (probably) leave for Sheffield from St. Pancras Station. 7.6 p.m. arrive Sheffield, Royal Victoria Station Hotel.

Wednesday, August 29.—Plant visitation at Sheffield, with reception and dinner in the evening by Sheffield Branch, Institute of British Foundrymen.

Thursday, August 30.—Excursion by motor to the Peak District and the Dukeries, Haddon Hall, Blythe, Edinstowe, Ollerton, Budby, Worksop and Anston.

Friday, August 31.—2.22 p.m., leave Sheffield. 5.0 p.m., arrive Manchester, Midland Hotel. Dinner of welcome offered by the National Ironfounding Employers' Federation at the Midland Hotel.

Saturday, September 1.—Excursion, visiting Smithfield Market, University, Royal Infirmary, Whitworth Institute, Trafford Park, Salford Docks, Manchester Docks, Town Hall, Albert Square, Cathedral, Royal Exchange, Art Gallery and Ship Canal.

Sunday, September 2.—Visit to Chester, and trip along the Dee.

Monday, September 3.—Plant visitation, Manchester district.

Tuesday, September 4.—2.50 p.m., leave Manchester. 4.50 p.m., arrive Birmingham, Queen's Hotel.

Wednesday, September 5.—Plant visitation, Birmingham district, with reception in the evening by Birmingham and Coventry Branches of Institute of British Foundrymen.

Thursday, September 6.—Plant visitation, Coventry district.

Friday, September 7.—Excursion by motor car to Kenilworth, Guy's Cliff, Warwick Castle, Stratford-on-Avon, Museum, Memorial Theatre, Harvard House, Trinity Church and Ann Hathaway's Cottage, etc. 4.24 p.m., leave Leamington. 5.55 p.m., arrive London, Hotel Cecil.

Saturday, September 8.—London, no arrangements.

Sunday, September 8.—London, no arrangements.

Monday, September 10.—London, official visit to Shipping, Engineering and Machinery Exhibition, Olympia. Lunch offered by the Exhibition authorities.

Tuesday, September 11.—2 p.m., leave London for Paris with the Institute of British Foundrymen party, *viâ* Dover-Calais. 9.40 p.m., arrive Paris, Lutetia and other hotels.

The programme on the Continent has already been outlined in these columns.

List of Visitors.

According to "The Foundry," the following are expected to form the party:—

Messrs. Stanley G. Flagg, Junr., Messrs. Stanley Flagg & Company, Philadelphia; C. E. Hoyt, secretary of the A.F.A.; L. L. Anthes, the Anthes Foundry Company; A. O. Backert, the Penton Publishing Company; G. H. Clamer, the Ajax Metal Company, Philadelphia; Franklin G. Smith, the Osborn Manufacturing Company, Cleveland; D. B. Anderson, Pittsburgh Engineering Company, Jeanette, Pa.; E. M. Ayers, Zanesville, O.; E. K. Bacon, Mansfield, O.; A. Baillot, Hull Iron & Steel Foundries, Limited, Hull, Quebec; F. R. Benson, president, Terre Haute Malleable & Manufacturing Company, Terre Haute, Ind.; N. T. Booth, Bethlehem Steel Co., Steelton, Pa.; William J. Brant, 1001, Bessemer Building, Pittsburgh, Pa.; F. J. Buckley, 737 Academy Street, Kalmazoo, Mich.; H. W. Burgess, Wallaceburg Brass & Iron Company, Wallaceburg, Ont.; Edward W. Campion, 228, North Drexel Avenue, Columbus, O.; M. B. Chambers, 5328 Harper Avenue, Chicago, Ill.; G. W. Clamer, Ajax Metal Company, Philadelphia, Pa.; W. A. Coventry, Grey Iron Casting Company, Mt. Joy, Pa.; Chas. G. Drozeski, 399, Keystone Avenue, River Forest, Ill.; Dr. L. J. Feid, Sen., Eighth and State Avenue, Cincinnati, O.; C. J. Flaherty, Johnson Browe Company, New Castle, Pa.; R. C. Foster, manager of sales, Stockham Pipe & Fittings Company, Birmingham, Ala.; B. D. Fuller, 614, Main Street, Niagara Falls, N.Y.; C. H. Gale, 1418, West Eighty-fourth Street, Cleveland, O.; C. S. Gilbert, Canada Iron Foundries, Ltd., St. Thomas, Ont.; W. R. Gilmore, Superior Steel Castings Company, Benton Harbour, Mich.; D. O. Green (or R. H. Mills), American Hominy Company, Chicago, Ill.; A. S. Haasis, Joseph Dixon Crucible Company, Jersey City, N.J.; Joseph E. Hansfield, president, Ohio Pattern Works & Foundry Company, Cincinatti, O.; George Hanson, Havana, Ill.; Vitus J. Honha, 1911 South Avers Avenue, Chicago, Ill.; C. A. Jackson, Louisville, O.; A. F. Jensen, Hanna Engineering Works, Chicago, Ill.; Percival Johnson, 1008 Real Estate Trust Co., Philadelphia, Pa.; A. J. Kennedy, president, Sandy Hill Iron & Brass Works, Husson Falls, N.Y.; G. M. Knotts, United Engineering & Foundry Company, Youngstown, O.; George H. Laib, Columbia Sanitary Manufacturing Company, Louisville, Ky.; David Logan, American Foundry Equipment Company, New York City; J. S. McCormick, J. S. McCormick Company, Pittsburgh, Pa.; L. H. McWane, president, Lynchburg Foundry Company, Lynchburg, Va.; Verne E. Minich, president, American Foundry Equipment Company, New York City; T. H. Monaghan, 1355 West Washington Boulevard, Chicago, Ill.; Harry D. Mousley, 2409, Cedar Avenue, Philadelphia, Pa.; A. J. Mummert, McQuay Norris Manufacturing Company, St. Louis, Mo.; J. B. Nordholt, president, Toledo Steel Casting Company, Toledo, O.; Edward S. Norvell, E. C. Atkins & Company, Indianapolis, Ind.; H. G. Hetzler, 167, Villa Street, Rochester, N.Y.; Clifton D. Pettis, 14, East Sixtieth Street, New York City; W. P. Putnam, 3726, Woodward Avenue, Detroit, Mich.; W. S. Quigley, 26, Cortlandt Street, New York City, Carl E. Ruefly, P.O. Box 211, Dover, O.; Bartlett W. Shaw, Walker & Pratt Manufacturing Company, Watertown, Mass.; R. F. Sherwin, Chicago Hardware Foundry Company, North Chicago, Ill.; J. S. Snyder, vice-president, Pittsburgh Rolls Corporation, Pittsburg, Pa.; H. B. Swan, Cadillac Motor Car Company, Detroit, Mich.; Alex. J. Theisen, secretary-treasurer, Great Lakes Foundry Company, Port Huron, Mich.; Jacob Walther, Dayton Steel Foundry Company, Dayton, O.; Walter Wood, 400, Chestnut Street, Philadelphia, Pa.

Investigation of Brass-Foundry Fluxes.*

The results of a series of experiments are given, and the nature of the action of the various fluxes used in copper, brass, and aluminium foundry practice is discussed. Fluxes are sub-divided into three classes—chlorides, which may react chemically with either the metallic oxides or impurities; deoxidisers, which essentially are intended to reduce the oxides produced during melting by exposure; and seals, which are intended to cover the surface of the melting and molten metal. As seals many fluxes fail, as they are not impervious to hydrogen; and most are not successful commercially owing to their corrosive action upon the crucible or container. The physical action of many fluxes is, however, of great importance; their action appears to be out of all proportion both to the quantity of flux used and to the time of its action. It is deduced that this depends upon the influence of such flux upon the surface-film of the molten metal.—C. W. HILL, T. P. THOMAS, and W. B. VIETZ. (*Am. Inst. Min. & Met. Eng.*, 64, 662-674.)

* Institution of Civil Engineers Abstract.

The Testing of Railway Couplings.

Messrs. W. & T. Avery, Limited, at their Birmingham Works, have just completed a large impact testing machine for the purpose of testing railway screw couplings, three-link wagon couplings and draw-bars by impact. The machine, which has been specially constructed for the Alipore Test House, Calcutta, is designed largely on lines similar to the machine installed at the National Physical Laboratory, Teddington, Middlesex, for a like purpose, although several improvements in the details of the machine have been made where thought desirable.

Fig. 1 shows the general arrangement of the machine.

The machine consists of a pendulum hammer and a suspended anvil, both of which are carried upon ball bearings mounted upon one common shaft, the whole being supported within a large double-sided frame built up of rolled-steel sections. The pendulum hammer weighs 2 tons and is raised to a maximum height of 2½ ft. The full maximum capacity of the machine is thus equal to 5 ft.-tons. The raising of the pendulum from its vertical position is effected through the medium of a motor-driven winch. The suspended anvil weighs 4½ tons, and is a U-shaped casting through which the pendulum hammer can swing quite freely.

The coupling under test is connected at one end to a central screw upon the anvil, and at the other is attached to a steel crossbridge provided with two

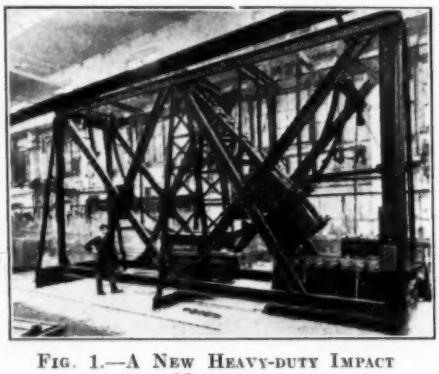


FIG. 1.—A NEW HEAVY-DUTY IMPACT MACHINE.

hardened-steel buffers. This crossbridge is carried upon the anvil by means of a hinged bracket which is provided with two straining screws by which an initial load of one ton is applied to the coupling prior to the test.

A special feature of the machine is the friction brake, which is connected to the anvil. This brake consists of two flat-steel reins which pass between strips of "Ferodo" material. By the side adjustment of a series of steel coil springs the friction of the brake can be so adjusted that it will give the maximum frictional resistance of 12 tons.

The pendulum hammer is provided with two steel buffer faces, which, on the downward spring of the pendulum, strike against the buffers of the above-mentioned crossbridge, thus applying an impact-tensile test to the coupling. The energy of the blow is partly absorbed by the friction brake and the suspended anvil respectively, the remainder being taken up by the coupling itself. In the event of the coupling breaking under the blow, the pendulum hammer will swing past the vertical and will travel up two circular tracks which are fitted with teeth. Two spring pawls upon the hammer fall into these teeth when the pendulum comes to rest and so prevents its return.

The machine complies with the conditions laid down by the India Office for the testing of couplings, in which particular consideration is given to the fact that the coupling must withstand, without fracture, three blows of 5 ft.-tons, and must not exceed certain limits laid down as regards extension and deformation. On the completion of the machine careful calibration tests were carried out at Messrs. Avery's works and a number of couplings subjected to test.

Behaviour of Refractories on Heating.

At the annual general meeting of the Refractory Materials Section of the Ceramic Society, MESSRS. H. S. HOULDSWORTH, M.Sc., and J. W. COBB, C.B.E., B.Sc. (both of the Fuel Department, Leeds University), followed up their Paper on "The Behaviour of Clays, Bauxites, etc., on Heating," presented at the Birmingham meeting last year (see JOURNAL, October 12, 1922), by submitting an account of further experiments made to determine how far, if at all, the permanent shrinkages shown by clays on heating were due merely to decreases in porosity as distinct from volume changes in the clay material itself.

In the treatment of cubes of kaolin it was found that the porosity did not change between 100 and 400 deg. C., but increased by 1.6 per cent. on heating for 24 hours at 450 deg. C., the temperature at which rapid dehydration of the clay took place. The porosity increased another 1.5 per cent. on firing to 550 deg. C. It should be remembered that the process of dehydrating kaolin at 450 deg. C. is continued, although very slowly, after a 24-hour period, so that the further increases in porosity determined between 450 deg. and 550 deg. C. were probably due to the further slight dehydration of the clay as well as to any further chemical decomposition of the clay molecule or crystal unit which might have occurred. The porosity slowly increased on heating to higher temperatures, being 1.4 per cent. greater at 1,000 deg. C. than at 550 deg. C. It was seen, therefore, that the shrinkages of the kaolin test-pieces could not be attributed to decreases in their porosities.

The true specific gravity of the clay remained unaltered up to 400 deg. C., but decreased considerably (from 2.642 to 2.521) on firing at 450 deg. C., a further slight decrease (from 2.521 to 2.510) taking place at 500 deg. C. It was seen, therefore, that dehydration of the clay at 450 deg. C. was accompanied by a pronounced decrease in its density, the further smaller decrease at 500 deg. C. being due presumably to the completion of the dehydration and of any other molecular decomposition occurring at 450 deg. C. The true density of the kaolin reached a minimum value when dehydration was complete. Little further change in specific gravity took place up to 600 deg. C., but at 650, 700, 750 and 800 deg. C. small increases in density occurred. These changes are in agreement with the slight shrinkages at 625, 680 and 760 deg. C. described in the authors' previous Paper. There was only a small further change at 850 deg. C., but, on heating to 900 deg. C., the specific gravity increased from 2.568 to 2.608. This change corresponded with the large shrinkage which took place at 880 deg. C. A larger increase in specific gravity (from 2.608 to 2.688) was observed on heating for 24 hours at 950 deg. C., this further change in all probability being associated with the large shrinkage occurring at 950 deg. C. Little further change in density was detected at 1,000 deg. C., the small increase noted being due probably to the completion of the change occurring at 950 deg. C. It was seen, therefore, that pronounced changes in the clay molecule, as indicated by alterations in the specific gravity, occurred at 400-450 deg. C., 850-900 deg. C., and 900-950 deg. C. corresponding with the dehydration of the clay at 450 deg. C., and the shrinkages at 880 and 950 deg. C. respectively, while smaller changes took place at 600-650 deg. C., 650-700 deg. C., 700-750 deg. C., 750-800 deg. C., and were probably associated with the small shrinkages observed at 625, 680 and 760 deg. C. respectively. The authors conclude that these latter changes may possibly be due to changes in the small quantities of impurities present.

The refractive index of kaolinite crystals was not altered by firing at 400 deg. C., but it decreased from 1.564 to 1.543 on heating at 450 deg. C., due, no doubt, to the dehydration of the crystals. The refractive index decreased from 1.543 to 1.518 after heating to 500 deg. C., and this further decrease was probably due to the completion of the change taking place at 450 deg. C. The refractive index is at a minimum after complete dehydration.

An Apprenticeship Course in Foundry Practice.—L.

By Ben Shaw and James Edgar.

COMMERCIAL IRON.

Instead of at once dealing with iron as it concerns the founder, it may be profitable in the first place to consider the subject of iron in a more general sense in order that the apprentice and young journeyman may recognise the fundamental distinctions between the various forms in which it is used commercially and the manner in which they are produced. A general account of this nature must necessarily be brief, but a better understanding of foundry irons is likely to result by considering the subject of iron as a whole, so that comparisons may be made between the various forms.

Wrought Iron.

In a commercial sense iron is used in one of three main forms, any of which covers a number of varieties according to the amount and character of the elements they contain or to the method of manufacture. Cast iron, wrought iron, and steel are, broadly speaking, the forms in which iron is used for commercial purposes. These, although consisting mainly of iron, vary in their chemical composition which considerably affects their physical properties and their facility for working. Wrought iron is the purest form of iron, and this may contain as much as 0.20 per cent. of carbon, a small percentage being invariably present in the purest iron. It is also remarkably free from other impurities. Wrought iron is comparatively soft and capable of being drawn into very fine wire. It is of a fibrous texture, and because of this it is considered to be stronger in the direction of the fibres than across them. It is malleable and, like platinum, can be welded without the use of any other medium. It is slightly stronger in tensile than in compression, the ultimate strength being approximately 25 and 18 tons per sq. in. respectively. Wrought iron is produced either from the ore direct or by refining pig-iron and scrap in a reverberatory furnace at a temperature not sufficient to maintain the metal in a molten state after the removal of the impurities, the iron being intermixed with a considerable amount of the slag formed in the process. Wrought iron has been defined by the Committee of Uniform Nomenclature of Iron and Steel of the International Association for Testing Materials as " malleable iron which is aggregated from pasty particles without subsequent fusion and containing so little carbon that it does not harden usefully when cooled suddenly." This definition is somewhat misleading, because all steels that are made to-day do not harden when suddenly cooled. Wrought iron is sometimes but not often used in the foundry. Its chief use now is for forgings, especially when welding is involved. For general construction purposes it has been for many years largely substituted by steel. Wrought iron is made from what is called " forge-pig."

Steel.

Steel is the next purest form of iron. It contains more carbon than wrought iron, and therefore covers a wider range than wrought iron. With carbon contents up to 0.35 per cent. it is referred to as mild steel, and with carbon between 0.35 and 0.60 per cent. it is medium steel, and above this figure hard by comparison. Generally the carbon contents may be as high as 1.5 per cent., and in what are usually referred to as special steels the carbon percentage may be higher, such as in wortle plates. In addition to carbon other elements are usually present in minor quantities; for manganese the quantity varies very much according to the uses to which the steel is to be put. The mild steel closely resembles wrought iron, but it has a crystalline structure and a very fine texture. It differs from hard steel in not having the property of tempering. Mild steel is ductile, malleable, and is stronger than wrought iron, particularly in tension, its ultimate strength being approximately 30 tons per sq. in. It is readily welded. With the medium steel the increase of carbon gradually increases the skill required to work it. It is only welded with difficulty with 1.4 per cent. of carbon, and is neither as ductile nor as malleable as wrought iron or mild steel. Special steels have other elements in addition to carbon introduced for specific purposes, and the steel is usually referred to as alloy steel and it is known by the name of the metal added, thus manganese, nickel, tungsten, vanadium, chromium, molybdenum, may be alloyed in varying proportions and are referred to as manganese steel, nickel steel, etc.

Cast Iron.

Cast iron is a less pure form of iron than either wrought iron or steel. Iron in this form contains approximately from 5 per cent. to 8 per cent. of impurities, and in some instances these may be as high as 10 per cent. The carbon contents vary, but invariably it amounts to about 3 per cent., the other elements consisting mainly of silicon, manganese, phosphorus, and sulphur. Cast iron has a crystalline structure and it is more open in texture than steel. It lacks ductility and cannot be welded. It is relatively weak in tension but strong in compression. The composition of cast iron and the manner in which it is cast has a considerable influence upon its strength, the tensile strength may be as low as 6 or 7 tons per sq. in., whereas, in special mixtures, cast under ideal conditions, it may be as high as 15 or 16 tons per sq. in. On the other hand, the compressive strength is considerable, averaging about 40 to 45 tons per sq. in.

Malleable Iron.

A special form of cast iron is rendered malleable after having been cast by a process of annealing. The iron used is white iron in which the carbon is almost entirely in a combined form The annealing process converts the combined carbon into free carbon in an amorphous condition which is different from the crystalline form of free carbon known as graphite. The casting is thus rendered tougher than ordinary grey cast iron. It is also rendered very ductile and malleable and can readily be bent. Briefly explained, the annealing process consists of exposing the iron castings to an oxidising action, such as is obtained by bedding them in oxide of iron or hematite. In this condition the castings are heated to redness and carbon is extracted to a depth depending upon the time they are allowed to remain at the temperature suitable for the oxidising action to take place.

These three forms of iron vary much in their application for specific purposes, and many factors must be considered in determining the form most suitable or most economical. Broadly speaking, however, it may be assumed that wrought iron is used for bent iron or forge work where its special properties of ductility are an advantage, but it is not usually cast. Cast iron, on the other hand, is not ductile and cannot be worked, but it is very fluid when in a molten state, and is exceptionally suitable for casting into moulds prepared to receive it. Thus innumerable shapes, intricate or otherwise, can be produced, and not only is the cost of production comparatively low, but cast iron, being a cruder form of iron, is the cheapest of irons. Steel takes up a somewhat intermediate position, it being capable of being cast into moulds, and being more or less malleable it can be worked within limits. It is a more refined grade of iron than cast iron, and special processes are involved to extract or reduce the impurities, which considerably affect the cost. The milder form has almost displaced wrought iron for structural purposes, it being capable of being rolled into numerous shapes, and, as a rule, steel that is used for casting purposes is also comparatively low in carbon. Steel castings have greater

strength and are more reliable than iron castings, but, owing to their additional cost, they do not displace cast iron excepting when the castings are subject to special strains or excessive shocks.

History of Iron.

Although foundrymen are more directly concerned with the casting of iron, it may be of interest to convey a brief idea of the antiquity of this metal. Some of the oldest specimens of iron are to be found in the British Museum, one of which is supposed to be nearly 4,000 years old, while another piece, representing an axe head, is believed to belong to the year 1370 B.C. There is, however, little evidence of a general use being made of iron until the period covered by 1,000 to 500 B.C. The Assyrians had attained considerable skill in the making of iron during this period and in its preparation for useful purposes. It will probably be interesting, particularly to young patternmakers, to realise the capacity of the Assyrians in this respect by reference to the finding of part of a saw 44 in. long among the ruins of the North-West Palace of Nimrod. Then according to discoveries made at Mycenæ, the Greeks, too, were familiar with the art about 600 B.C., and more recent discoveries in the Austrian Tyrol and Switzerland demonstrate the period of transition from the bronze to the iron age about the same time in Central Europe. There is ample evidence to show that the Romans assiduously developed the production and use of iron particularly during the time immediately before and at the beginning of the Christian era. During these early periods it should be noted that there is no evidence of other than wrought iron and steel being made. The production of steel is quite consistent with the use of charcoal to reduce the ores. It is quite probable that cast iron was produced during this early period, but owing to it not being malleable it would be apparently useless. Whether it was actually produced or not there is no evidence to show. Lower believes that cast iron was made in Sussex in 1350, and there is a cast-iron slab in Burwash Church, Sussex, which would appear to have been made about this time. The exact date when cast iron was put to a practical use, however, is not known, but it seems evident that its practical application commenced on the Continent about the end of the fifteenth century. The Catalan forge was the principal means of reducing the ores before cast iron was produced. It is generally agreed that with this primitive form of furnace a sufficiently high temperature could not be obtained to melt the iron and effect its combination with 3 to 4 per cent. of carbon, which is largely responsible for those physical characteristics which distinguish cast iron from the other ferrous metals. Shaft furnaces came into use in this country in the fourteenth century. These two forms of furnaces were used for a long time in the production of wrought iron only, but variations were made in the size of the shaft furnaces from time to time, when these were found capable of producing fluid iron, the height in particular being increased. Charcoal continued to be the means of smelting until about the beginning of the seventeenth century, when Dud Dudley first converted coal into coke and used it as fuel for smelting. There is no doubt, however, that the use of charcoal was the general practice for long after this time, although the scarcity of this fuel curtailed progress in this country whereas on the Continent where it was in greater abundance the iron trade flourished. It is interesting to note that a special Act was passed during the reign of Queen Elizabeth to preserve the woods from the depredations of the iron makers. It was not until about the year 1730 that a real impetus was given to the industry, and this was due to improvements in the art of working iron which put to more practical use coke as fuel. Abraham Darby was responsible for these improvements, which he demonstrated at Coalbrookdale in Shropshire. The revival resulting stimulated the production of iron castings and had some influence on the production of steel castings. Thus although founding is an art of great antiquity, that dealing particularly with iron castings is apparently of comparatively recent growth.

Iron Ores.

Apart from aluminium, iron is the most abundant of all the metals. It is obtained from ores which are widely distributed in the different countries. The most important ores for smelting purposes are those that contain oxygen, and these form the recognised group from which iron is produced. The other group which contains iron and known as iron pyrites contain a considerable proportion of sulphur, and as this element is ruinous to iron, these ores are used for other purposes. The best of the ores used for smelting are the oxides of iron. These generally contain a greater percentage of iron than the carbonates. The oxides of iron include the magnetite and hematite ores, while the carbonate include spathic iron ore, clay ironstone, blackband, etc. Magnetite or magnetic oxide (Fe_3O_4) is distributed in two chief forms, in a large crystalline and small granular state. In its purest form this ore may contain as much as 72.4 per cent. of iron. America and Sweden, in which this ore is mined in large quantities, have rich deposits.

Red hematite (Fe_2O_3) occurs as kidney-shaped crystalline masses and in granular form. In its purest form it may contain up to 70 per cent. of iron, but generally the ore as mined contains approximately 60 per cent. These ores are comparatively free from such impurities as sulphur and phosphorus, and the iron produced from them, known as hematite iron, is generally used for making steel by the acid process.

Important deposits of this ore are mined in different parts of America and in Spain, while in this country the ores of Cumberland and Lancashire produce hematite iron of the best quality.

The brown hematites ($Fe_2O_3H_2O$) contain varying quantities of water and are usually phosphoric. The iron produced from these enters largely into foundry irons and in the making of steel by the basic process. The percentage of iron is somewhat lower than in red hematite and varies considerably up to about 60 per cent. Much of this ore is mined on the Continent, in Canada and America, while in this country Northamptonshire has probably the most important deposit.

The spathic ores ($FeCO_3$) occur in a crystalline form and also mixed with clay as clay ironstone, or clay and coal as blackband. These are the sources of much forge and foundry irons. The percentage of iron varies considerably from about 30 to 40 or 45 per cent. Staffordshire, West Yorkshire, and South Wales ores give an iron which is particularly suitable for making wrought iron, and it is also advantageously employed in the foundry. The amount produced, however, is comparatively small. The Cleveland ironstone deposits of North Yorkshire are considerable and the iron produced from it is highly phosphoric. Lanarkshire has a considerable deposit of blackband which is moderately rich in iron.

Extraction of Iron.

The extraction of the irons from these ores is now more generally done by the fusion process by which the mass is made fluid, the impurities more or less floating as slag on the molten metal being separated and the metal run into pig-iron. This necessitates considerable heat because the ores are very refractory. This method, however, is the only practical way of dealing with large quantities. The method formerly adopted and known as the semi-fusion process consisted in the fusion of the ores by heat into a spongy mass of metal. The slag which this contained was gradually removed by hammering, heating and again rehammering, the process being repeated until impurities were practically removed. This latter process is still used, although to a very limited extent, and the principle is somewhat similar to the modern method of producing wrought iron by the puddling process. The fusion method is the more practicable method, and in this way pig-iron is produced in varying quantities containing 5 to 10 per cent. of impurities, and these are converted into the various forms that are required for commercial purposes.

Although the process for the extraction of iron from their ores are comparatively simple, the chemical reactions that take place are of a complex character, and we do not propose dealing

with them here. The ores are generally calcined, that is heat-treated, in order to remove water carbonaceous matter, carbon dioxide, and other volatile substances. This process, however, is only applied to the less pure ores, more especially the carbonates. As a rule no preliminary treatment of this kind is necessary for the magnetites and red hematites, although brown hematites are sometimes calcined, though magnetite is often weathered to remove the sulphur as a soluble sulphate.

Blast Furnace.

The reduction of the ores after this preparatory treatment is done in a shaft furnace, now more commonly known as a blast furnace. The process is known as smelting. The reduction results from a combination of the ore and carbon in the form of coke or charcoal at a very high temperature. The carbon uniting with the oxygen of the ores and escaping as carbon monoxide or carbon dioxide, leaving more or less impure iron which collects in a fluid state at the bottom of the furnace from which it is tapped. In order to separate the earthy matter and give it fluidity, so that it forms a protective covering on the iron when in the furnace, a flux is used—usually limestone. Thus the furnace is charged with coke or coal, iron ore and limestone. Some ores, however, are self-fluxing.

The modern blast furnace is a very large structure having an internal shape somewhat similar to that shown in Fig. 1. The height and diameter vary, the former being from 70 to 100 ft., while the diameter at the hearth, which is usually smaller than elsewhere, may be from 11 to 15 ft.

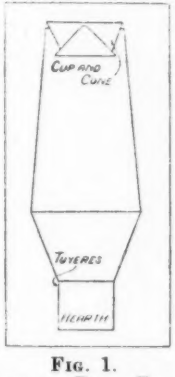


FIG. 1.
OUTLINE OF A BLAST FURNACE.

They are charged at the top by means of cup and cone arrangement. Considerable air supply is necessary to maintain combustion, and at such a pressure that will penetrate the mass, and for this purpose special blowing engines are employed.

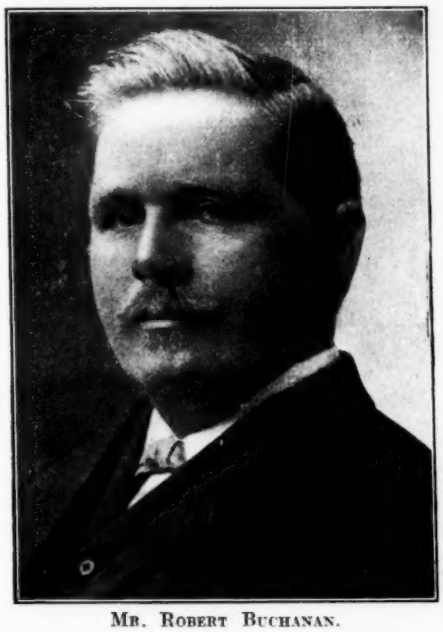
The pressure of the blast varies, according to whether the furnace is fed mechanically or by hand, from about four to ten pounds per sq. in., the lower pressures being more suitable for hand charging. Except in the production of cold-blast pig-iron, the temperature of the air blown into the furnace is raised to about 600 to 800 deg. C. to maintain a high temperature in the furnace. When the process of reduction has been completed the furnace is tapped to remove the slag which runs out in a molten mass and afterwards the iron is tapped from the hearth and runs direct from the furnace to specially prepared moulds or "sows," resulting in the commercial pig-iron with which we are familiar. This iron is divided into three main classes for conversion into steel forge and foundry irons. In some instances the molten metal from the blast furnace is taken direct for refining treatment.

Nickel as an Alloy.—A number of American foundries are said to be experimenting with cast-iron to which from 2 to 4 per cent. of nickel has been added. In the research department of the International Nickel Company of Canada, Limited, there has been developed a nickel-bearing type of stainless steel said to contain from 20 to 40 per cent. of nickel, 6 to 12 per cent. of chromium, and 0.25 to 2 per cent. of silicon, which can be readily machined and fabricated. One rolled sample tested gave:—Tensile strength, 44.5 tons per sq. in.; yield point, 26 tons; elongation on 2 in., 20 per cent.; and reduction of area, 50 per cent.

"Moulders" of the Industry.—No. 9.

Mr. Robert Buchanan.

Mr. Buchanan served his apprenticeship as a moulder with Messrs. John Ure & Company, iron-founders, Dumbarton, Scotland. This firm specialised in castings for marine engines, but also did a considerable amount of jobbing work. When his apprenticeship finished he had further experience in the foundry of the Barrow Shipbuilding Company, Barrow-in-Furness. After further experience as manager of foundries in Glasgow and the East of Scotland, he went to Birmingham as foundry manager to Messrs. W. & T. Avery, Limited, Soho Foundry, about 25 years ago. Whilst there he carried out many experiments with cupolas, and his experience and experiments have been detailed in numerous papers, in technical journals, and in lectures to foundrymen. For a number of years past he has been foundry expert with a large firm of pig-iron and steel merchants.



MR. ROBERT BUCHANAN.

He was one of the founders of the British Foundrymen's Association, now merged in the Institute of British Foundrymen, and was its first President.

He is a Fellow and Medallist of the Royal Society of Arts, a past-President of the Staffordshire Iron and Steel Institute, and now serves on various committees of the British Cast Iron Research Association, and of the British Engineering Standards Association.

Institute of British Foundrymen.

Newcastle Branch—Junior Section.

At the invitation of the Team By-Product Coke Company, Limited, the Junior Section visited the Gateshead Works of this concern on Saturday, July 7. The complete process, from the washing of the coal to the discharging of the coke ovens, was demonstrated, following which the methods of operating the by-product plant was explained. After inspecting the laboratory tea was served to the visitors.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, have secured an order for 25 heavy main line locomotives for the Buenos Ayres Great Southern Railway. These locomotives, which are intended for goods traffic, are of the 4-8-0 three-cylinder superheated type, with double bogie tenders for a gauge of 5 ft. 6 in. The locomotives will burn oil, and will be built at the firm's Scotswood Works, Newcastle-on-Tyne.

XUM

Hardened and Tempered Malleable Castings.*

By E. K. SMITH, Lakeside Malleable Castings Company.

Malleable iron castings have reached their present place in commerce, through certain unique qualities, chief of which has been their malleability, or ductility. Composed of practically pure iron (ferrite), their softness, resistance to shock, and machinability, have given them an increasingly large field.

Recently there has been considerable demand for medium-grade tools, intermediate between the familiar cheap German variety, which breaks so easily, and the best cast-steel tools, at comparatively high prices.

It is obvious that the best grade of malleable will not make a first-class hatchet, as the head will flatten out, and the edge turn over, unless those parts have been in some way hardened. Such a condition brings up this question of hardening malleable. As we had inquiries in regard to the possibility of hardening parts of castings, it seemed worth while to conduct a series of experiments, with a view to determining:

First.—The feasibility of hardening parts of malleable castings.

Second.—The nature of the hardened product.

Third.—Processes best adapted to hardening.

Information on the subject was extremely scarce. Malleable has of course been case hardened, but results have not been very satisfactory, unless the work has been in very expert hands. Even of this process, there has not been much information available. In fact, the average malleable foundryman, when asked for information regarding hardening of malleable, says positively: "Malleable cannot be hardened."

Experiments to Determine Hardness.

As a preliminary experiment, a number of malleable bars were heated to various temperatures, and quenched, with the rather unexpected result that the quenched metal was extremely hard, and in many cases, had a very fine grained grey fracture, greatly resembling steel. As a practical test, a bar was roughly ground to the shape of a twist drill, then hardened. Successive samples of brass, grey iron, malleable, steel, and hard white iron were drilled with this tool. This last was rather a surprise, as in the past the author had been able to drill hard iron only by means of high-speed steel.

In order to determine the actual usefulness of hardened malleable under ordinary shop conditions, a number of hammer heads were cast, hardened, finished, and supplied to carpenters' shops, despatch departments, machine shops, and other departments where hard use was certain. The results were surprisingly good—three months of hard service failed to develop flaws in any of the hammers, although a number of handles had to be replaced. It was notable that none of the hammer heads had "mushroomed," as would soft malleable iron, and none had chipped, as would over-hard steel.

Practical tests having shown that malleable cast-iron could readily be hardened, and that the hard product had very considerable shock resisting qualities, an attempt was made to determine what methods could best be adapted towards hardening malleable, also what would be some of the difficulties. To this end several hundred samples of various shapes were cast, and hardened, in diverse ways. For close temperature control, a small electric muffle furnace was found ideal, although rather slow in bringing samples to temperature. For quick work, the ordinary blacksmith forge gave excellent results, after a little practice. For instance, one hundred hammer heads were hardened in one hundred minutes, with a loss of only one casting, which was burned.

Warm water was found best for quenching, and quenching cracks were eliminated by dipping the heated hammer head (about 925 deg. C.) in the water two or three times, with intervals of about one second between the quenchings. Hardness readings on one hundred samples varied from 40 to 55 scleroscope, which is a satisfactory range for this kind of tool. It was surprising that the rather wide range in quenching temperatures made little difference in the hardness of tools. In this connection is is pertinent to state that scleroscope hardness readings on some twenty high-grade steel hammers ranged from 40 to 75. No particular attempt was made to arrive at costs, but it seemed probable that hardened malleable could be produced and finished at less cost than steel of similar physical characteristics.

In order to determine as closely as time permitted, the physical and microscopic nature of hardened malleable, a number of standard 5/8 in. test bars were heat-treated in various ways, and results recorded. It is of course understood that the experiments tabulated up to this time in no way cover the field of heat-treated malleable in its entirety, their purpose being simply to show the possibilities of the methods, and to give sufficient data to enable the metallurgist to prescribe special heat treatment, should he be called upon to produce malleable castings partly, or wholly, hardened. The heat treatment would obviously depend upon usage which the castings would undergo, and cost considerations.

The results shown below were obtained with iron of various compositions, the general hard iron analysis averaging about: Silicon 1.05 per cent., sulphur 0.056 per cent., phosphorus 0.14 per cent., manganese 0.27 per cent., total carbon 2.40 per cent.

TABLE I.

Sample.	Max. stress tons per sq. in.	Per cent. Elongation.	Yield point tons per sq. in.	Scleroscope hardness.
Hard Iron	16.2	0		50
Malleable	24.1	18.0		16
No. 61—Quench 1080	14.8	1.0		42
No. 615—Quench 1080 T 645 ..	30.9	1.5		33
No. 628—Quench 910 T 645 ..	14.8	1.5		60
No. 611—Quench 910 T 645 (1-hr.)..	41.7	2.5		34
No. 623—Quench 910 T 645 (¾-hr.)..	48.2	2.5		25
No. 624—Quench 910 T 425 ..	63.9	1.5		30
No 615-2—Quench 885 Heat to 760 Cool slow	40.4	6.5	30.6	25
No. 68-1—Quench 885 Heat 760 Cool to 425 Quench 425	42.5	7.5	35.1	30

Possibilities of Hardened Malleable.

While the subject of hardened malleable has not been investigated to any great extent, the experimental data shows a field for research, and probably for commercial processes. A properly made malleable casting offers great possibilities, for as malleable, it is extremely soft, and almost free from combined carbon. By proper heat treatment, a desired part of the carbon may be recombined, giving a metal of the required hardness. A slightly more complex heat treatment will produce a moderately hard, very strong material, the sample showing 42.5 tons per sq. in. ultimate strength, 35.1 tons yield point, and 7.5 per cent. elongation.

Just what would be the commercial field for malleable castings either wholly, or partly, hardened, is of course debatable, but it seems probable that such castings will be used in certain lines.

Several advantages of such material are apparent, and it may not be out of place to mention such advantages, coupled with illustrative examples.

(1) Where part of castings must be sufficiently hard to undergo great shocks without "flowing," or fracture, while the bulk of the castings must be soft and tough. Example—Ordinary claw hammer. The face can be hardened by a single, rapid heat treatment, to a hardness of say 50 scleroscope, while the remainder of casting is extremely tough.

(2) Where a good deal of machine work is required, this can be done first, then the casting, or part of it, can be hardened. Example—Machine parts subject to wear. Machine operations can be

* Abstract of a Paper read before the American Foundrymen's Association at the Cleveland meeting.

made at high speed on the soft malleable, then the part subject to wear can be hardened, as required.

(3) Where a smooth surface is needed, or where light sections must be run, the well-known advantages of malleable along these lines can be utilised, while a brief heat treatment will change the metal to what is practically hardened steel. Examples—Certain articles of cutlery and hardware, where the handles must have considerable toughness, while cutting edges must be hard, and surface of whole casting is required to be smooth. For instance, wire cutters.

(4) Where part of the casting must resist a file. Example—Automobile locks, part of which must be tough, part hard.

On account of its flexible composition, hardened malleable offers an infinitely wide field for varied physical properties, and when the desired qualities are known, a very little experimentation should tell whether a suitable material could be produced commercially.

A Portable Pig Breaking Machine.

The two illustrations, Figs. 1 and 2, show a portable type of pig-iron breaker, which has for its object the reduction of labour costs involved when pig-iron is broken by sledge hammer. This particular machine, though a comparatively recent innovation, has been installed in the works of

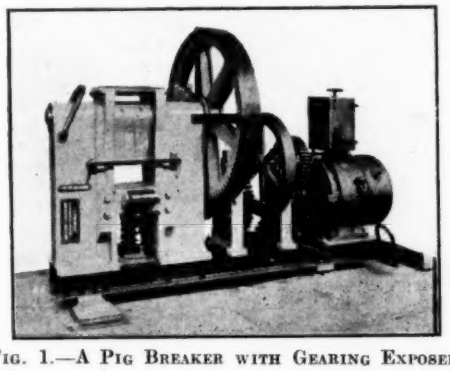


FIG. 1.—A PIG BREAKER WITH GEARING EXPOSED.

Messrs. Harland & Wolff, Limited, of Belfast, the Daimler Company of Coventry, who employ three, a number also used by Messrs. Vickers, Limited. It is manufactured by Messrs. George Green & Company, of Keighley.

As will be seen from the illustrations, it is arranged on a mild-steel girder base, which allows of its ready transport by crane from one pig-iron stack to another. The driving is through reduc-

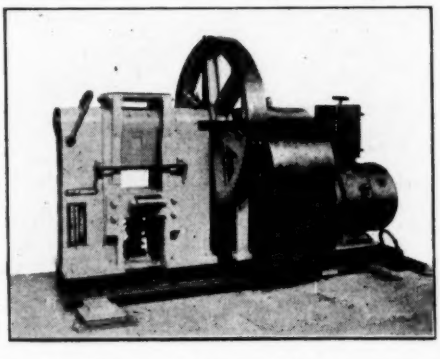


FIG. 2.—PIG-IRON BREAKING MACHINE WITH THE GEARS PROTECTED.

tion gearing and is actuated by a 5 to 7½-h.p. motor. The output is 12 tons per hour when breaking into four pieces, or practically double if the cupola can take half pigs. The manufacturers state that the largest hematite "sows" can easily be broken. The shackles at the right-hand side of the picture are used for transporting the machine.

Fig. 1 illustrates the type of gearing used, while Fig. 2 shows the method of protecting them from dust.

Elementary Notes on Core-Making Materials.

BY NEVILLE DEANE.

The basis of all cores is sand, varying from a strongly-bonded sand to sea sand with no natural bond whatever. The simplest form of core is that consisting of a naturally-bonded sand, moulded to shape in the core box—or on a core machine—and used straightaway. Usually, however, it is necessary thoroughly to dry the cores to prevent blow-holes, due to the evolution of steam from the moisture in the sand coming in contact with the hot metal. The larger number of cores cannot, however, be satisfactorily prepared in such a simple manner.

It is necessary to consider what properties a core should have before deciding on a suitable material or mixture.

In general these are: (1) Green strength or strength when freshly moulded; (2) dried strength or strength after baking or drying; (3) porosity, by which, in this instance, is meant the property of allowing gases to pass through the body of the core to the vents; (4) ease of extraction after the casting is made; (5) surface which the core will bestow upon the casting; (6) cost of materials and manufacture; (7) the property of drying and baking without warping or shrinking.

In many cases one material will give more than one property to the core, i.e., it may give both green and dry strength.

The number of materials for mixing with the sand is legion, a few of them being hay, straw, horse manure, molasses, sawdust, resin, gums of various sorts, flour paste, clay, coal-dust, linseed oil and other oil of a kindred sort, pitch, pieces of coke, wax, and iron rods and grids.

Of these materials some, such as hay, straw, pieces of coke, etc., provide a certain amount of strength, but principally assist in allowing the gases to escape freely, those similar to gums and pastes are productive of strength, which is destroyed by the heat of the metal, allowing easy extraction from the castings, whilst iron rods and grids are necessary in intricate cores to support the core material and prevent warping.

From all these varieties of material it is difficult at first to select a suitable material for the cores for a particular casting. In this case, the foundryman should consider his finished casting. If the casting is intricate, rendering core-extraction difficult, then he must use as a basis a weakly-bonded sand. To add the necessary strength he may only use materials which will be destroyed by the heat of the metal, that is carbonaceous material of a suitable kind. The resultant core is generally in the nature of a compromise between the ease of manufacture and ease of extraction. Cores made of a clayey sand are easy to make but sometimes impossible to extract, whilst sea-sand and oil cores are easy to extract but require a considerable care in making.

Taking sea-sand and oil cores as being probably the best of all, it is possible to produce cores more easily by replacing part of the sea-sand with naturally-bonded moulding sand, to an extent governed by the nature of the casting. In large cores, if something cheaper is required, resin may be used in place of the oil with success in many cases. The cores, however, are not so waterproof as if made with oil, and must be used at once.

Resin is useful in cores for aluminium castings, since it softens on contact with the hot metal, allowing the metal to contract freely without cracking. In considering the contraction of metal, such materials as hay, chopped straw, sawdust, etc., have a place. These burn out with the heat, allowing the sand to be crushed, but at the same time, since the core is not a homogeneous structure, the surface may suffer. That is, a piece of sawdust may be on the surface and will be likely to fall off, leaving a small lump on the casting. With a mixture of oil and sand this is impossible, since the oil coats each sand grain evenly. In many cases, however, small blemishes of this nature are not worth regarding when cheaper materials may well be used.

XUM

Vanadium in Iron Foundry.

By J. Kent Smith, O.B.E., M.I.Brit.F.

The benefits conferred by, and the best methods for, the judicious application of vanadium in the steel foundry have already been described by the author in detail. The vanadising of cast iron can, and does, effect benefits quite as great—but naturally of a different order—in the iron foundry, and these benefits are most marked in the case of those foundries specialising in "difficult" work.

It has been shown that vanadium exercises its influence on steel along three lines at least—preferentially in the matter of one and concurrently in the matter of the other—where the steel thus to be modified is of the usual "engineering" or "subsaturated" class, or, in other words, where it contains the two major components, pearlite (wherein lies the whole of the carbon content of the steel) and ferrite (or structurally free iron), containing no carbon. Grey cast iron has been described as essentially an impure steel containing in addition another constituent absolutely foreign to all good steels. This constituent is graphite, i.e., elementary carbon quite isolated and uncombined, particles of which are interspersed more or less regularly through the steel-like main mass. In ordinary grey iron the proportion by weight of this graphite usually lies between 3 and 4 per cent. Graphite is of a mineral—and not at all of a metallic—nature; it must thus disrupt the continuity of the metallic mass. The strength of grey cast iron must therefore obviously reach an early limit, and equally obviously that iron cannot have any appreciable amount of ductility or, when hot, of malleability. Further, any addition of a metallic nature must influence the metal portion only; no metallic addition can possibly be expected to affect the fundamental properties of the mineral inclusion. Consequently the results of the addition of vanadium to cast iron are not of a spectacular nature, or of any such nature as impressibly to be demonstrated in the mechanical testing laboratory.

It is true that, with certain articles, the later hydraulic test shows those results at once in bold relief; with the majority, service performance is rather the indication of the great improvements conferred by vanadium upon cast iron. Bearing the above constantly in mind, let us deal categorically with many salient points. First and foremost inevitably we must consider what quantitative effect upon the tensile strength of cast iron is produced on the addition of vanadium to it. From what has already been said, it is apparent that such cannot be stated in one omnibus figure. Since vanadium is such a powerful and efficient scavenger, its correct addition to a dirty weak iron whose weakness is largely due to excessive oxygen content—say a truly burnt iron—would be expected to, and does, raise the strength of that iron very greatly. Where an iron does not require so much scavenging, the main strengthening improvement of vanadium would lie in its effect upon the composition of the pearlite constituent, aided somewhat by further purging of, and solid solution in, the ferrite constituent. But, as has already been said, the interspersion of what are in effect mineral particles imposes a limit to the possible tensile strengthening of the iron. In a few words, it may be said that the increasing merely *of tensile strength* is less in arithmetical proportion, as the iron to be vanadised is of better quality.

Effect as Shown by Tensile Testings.

To take a few averages from numbers of tests (many of which have never been previously published):—

(*a*) The addition of 0.2 per cent. of vanadium to a series of dirty, burnt irons increased their average initial tensile strength from 5¼ to 8¾ tons per sq. in. In every case analyses of the vanadised iron revealed the fact that most of the vanadium had been used up in scavenging, with the removal of the scavenged products to the slag and scum.

(*b*) The addition of a like amount of vanadium to a series of cylinder irons having a tensile strength of 11.1 tons per sq. in. increased their tensile strength to 15.4 tons per sq. in.

(*c*) The addition of 0.15 per cent. of vanadium to a high-grade air-furnace iron—little cleansing had to be done by the vanadium—raised its tensile strength from 13½ to 15 tons per sq. in.

Transverse Results.

A very similar analogous curve of improvement is demonstrated by the averages of many transverse tests made on similar irons.

(*a*) Poor, dirty, burnt cast irons, breaking under transverse tests with an average applied load of 11¾ cwt., when treated with 0.2 per cent. of vanadium, gave an average transverse test on the same sized bars of 19½ cwt.

(*b*) Good cupola iron treated with 0.15 per cent. of vanadium was raised from a transverse strength of 22 cwt. to one of 30½ cwt.

(*c*) A series of high-grade air-furnace irons, each treated with 0.15 per cent. of vanadium, had their average transverse figures increased from 34 cwt. to 38 cwt.

(*d*) In another case, 0.13 per cent. of vanadium was added to a very high grade of selected iron in the air furnace. A sample of the iron taken immediately before vanadising gave a transverse test of 36 cwt.; after vanadising the charge, the metal showed a transverse test of 39½ cwt.

In each of the above cases the average deflection figure was precisely the same after vanadising as before, showing that no part of the gain in transverse strength could be due to any simple hardening action. Brinell hardness tests made on all the sample bars gave figures exactly confirming this deduction.

Compression Tests.

Under compression tests the value of the addition of vanadium to iron is well marked.

(*a*) The addition of 0.2 per cent. of vanadium to a series of good-quality irons, having an initial average compressive stress of 60 tons per sq. in., raised it to 67 tons per sq. in.

(*b*) Somewhat similar, but slightly harder, irons gave 65 and 72 tons respectively before and after vanadising.

(*c*) The average of a series of tests made on chilled bars of air-furnace roll-iron was raised to 112 tons from 97 tons by exactly similar vanadising treatment.

Again Brinell hardness tests on the various samples showed identical figures, both before and after vanadisation.

Other Features.

These beneficial effects are shown in the testing laboratory, but even more important benefits, which only become apparent at later stages of work, or even in service conditions, are conferred upon cast iron by vanadisation. Reference is made more particularly to the elimination of porosity, and the great improvement effected in resistance to wear. And it is these which the author considers two of the most notable examples of the extreme value of vanadium to the ironfounder. Shortcomings which are detectable in the testing laboratory are bad enough, but, at any rate, the financial loss arising from them generally finishes at the foundry floor. On the other hand, the failures due to porosity are only discovered on the hydraulic testing bench after a very heavy expenditure on work, which work is utterly wasted as the result of failure. Therefore, the producing cost of the satisfactory finished article goes up by leaps and bounds, and the overhead cost greatly increases also as the result of diminution of output. The porosity referred to is not sufficiently gross to be distinguishable by the naked eye, or even at comparatively low liquid pressures, and is particularly

prone to occur at more or less abrupt changes of section. The correct incorporation of vanadium with the suitable cast iron eliminates the trouble entirely, and, though the cost of the ladle metal be quite materially increased as the result, the real cost of a run of the finished articles is much reduced.

Any attempt to correlate the hardness of a metal with its resistance to wear is futile; no such correlation can exist. Although vanadised cast iron is no harder to the indentation or scleroscope test than unvanadised cast iron of the same type, it resists wear very much better. This is probably due both to the inherently tougher nature of its ferrite—whether that portion is structurally free or alloyed in its pearlite—and also to the better and more even distribution of the carbide and carbon constituents, the graphitic portion of which acts as an efficient natural lubricant. Thousands of actual working results have demonstrated this fact, a fact which is not demonstrable by any of the rapid tests of the physical laboratory. The value of vanadising cast iron for use in gears is at once apparent.

Elimination of porosity assumes perhaps its greatest importance in castings intended to be used in the transmission of hydraulic power, or in high-pressure steam work. It assumes also great importance in many castings for cylinders, which latter are further greatly helped in service by their increased resistance to wear.

It has been said that an ounce of practical trial is worth a ton of theory. Theory in this case is completely vindicated by the fact that many manufacturers are, to the writer's knowledge, using vanadium in their iron foundries with the idea only of combating porosity and wear; they find that to do so is greatly to their financial benefit.

Practical Considerations.

The method of application of the alloy is simple, the two points having to be guarded against especially being those of (*a*) non-dissociation and (*b*) of low solubility. With cast iron we are dealing with a molten metal several hundred degrees in temperature below that of steel; hence the importance of both points becomes paramount, as solubility conditions are lowered, as is also less molecular activity in the bath of molten metal. To avoid (*a*), a "carbonless" alloy *must* be used. With regard to (*b*), simultaneous content of manganese and silicon with vanadium in its iron alloy promotes its rapid solution, and high-silicon, high-manganese descriptions of ferro-vanadium are best suited for use in the iron foundry.

It is worthy of note that, since the utmost quantity of a 40 per cent. ferro-vanadium to be incorporated with cast iron lies in the order of 11 lbs. per ton, a content of even 10 per cent. silicon and 5 per cent. manganese in it is practically negligible as far as the chemical constitution of the finished iron is concerned. In such extreme circumstances the silicon of the finished iron would only be raised by 0.05 per cent. and the manganese by (under) 0.03 per cent., both of which are quantities well inside the ordinary working limits of drastic scientific control as applied to an iron foundry.

Application to Cupola Metal.

Owing to the ready oxidability of vanadium, it is palpably impossible to add it, with any degree of success, to the cupola charge. The cupola metal should be melted as usual; as it is flowing into the ladle, and after allowing the floor of this to become covered by molten metal, broken ferro-vanadium—in the smallest pieces convenient, granules for choice—is added to the stream as it falls from the launder. Slag is naturally "shuttered back" during the addition. After the ladle has been filled with the necessary amount of molten metal, its contents are well rabbled, preferably with a wooden pole.

Air Furnace Procedure.

If the air furnace be used for the production of the melt, conditions are equally simple. The charge is melted down as usual, and then a couple of pounds per ton of ordinary lump ferro-manganese is rabbled into it to cleanse it. About twenty minutes or half an hour before tapping the ferro-vanadium is introduced—preferably in small lumps from nut to egg size—and well rabbled in. If a portion only of the contents of the air furnace are to be vanadised, the same method of procedure is resorted to as in the case of the cupola-melted iron. Any vanadisation in the ladle should not be done on quantities less than 4 cwt.

Shrinkage of Vanadised Cast Iron.

The shrinkage of vanadised cast iron is practically normal; by the laws of nature, there is a tendency for it to be slightly greater than that of unvanadised cast iron of the same type, but the practical difference is so small that no alteration need be made whatever in the patterns.

Vanadium and Chilled Rolls.

Since one of the important classes of products made from vanadised cast iron is that of chilled rolls and other chilled articles, the question arises as to whether vanadium materially affects the depth of chill. Once more we are faced with the fact that, since the composition of cast iron covers such a wide range, approximately definite conditions must be considered in answering.

To give examples:—When a roll-iron containing a little less than 1.0 Si, 0.5 Mn, 0.4 P. 0.05 S, 0.55 CC. and 2.60 per cent. Gr, is vanadised by the addition of 0.22 per cent. of vanadium (of which 0.16 per cent. vanadium ultimately remains in combination with the iron, the other 0.06 per cent. being used in scavenging it—mainly as to nitrogen), the chill is increased in standard practice by about 12½ per cent. In harder irons, where the silicon only approximates 0.5 per cent., the effect of a similar vanadium addition is more marked, resulting in an increased depth of chill of 25 per cent. But with softer grades of iron the increased depth of chill due to vanadising is less than with roll-iron, and becomes steadily less as the original softness of the iron increases, until, with ordinary grey foundry iron, the disposition to chill (with the same amount of added vanadium) is about normal. In making vanadised chill-rolls in the foundry, provision should be made therefore, either by slightly increasing the normal silicon or by using a metal chill in the mould of lesser degree of intensity. It only remains to remark that vanadium improves greatly the qualities of malleable iron. This product is made by suitably annealing white cast iron in "oxide" or other "packing." The carbon in the interior layer is oxidised, but the temperature required to effect this is not sufficiently high to bring about the complete oxidation of the dissolved vanadium in that layer. In the interior the combined carbon is changed to the graphitic or temper form, and the mass consequently is toughened by the vanadium as before described. Hence vanadium adds increased *toughness* to malleable iron in greater measure than it adds increased *strength*.

[From the section to which we have given the sub-heading "Other Features," the impression is given that the liquid contraction is less in vanadised cast iron, as the porosity described is one which the foundry metallurgist would certainly designate as such. Yet in the paragraph headed "Shrinkage of Vanadised Cast Iron," the reverse impression is received.—ED.]

Open Contracts.

Bucharest, August 6.—The Roumanian State Railways require the following parts of greaseboxes and coupling hooks:—Iron ties, with screwholes for greaseboxes, screw plugs for lower boxes, pressure screws with band for pressing lower boxes against upper boxes, spring ties for shoes, coupling screws, nuts and safety hooks. La Direction Generale des Chemins de fer Roumains, Service P (Calea Victoriei No. 124), Bucharest. The Department of Overseas Trade (Room 50), 35, Old Queen Street, London, S.W.1.

London, E.C., July 17.—Stores, for the Great Indian Peninsula Railway Company, namely:—(1) Firebricks (fee for specification, 7s. 6d.); (2) points and crossings, etc. (5s.); (3) brass sheets, copper, tubes, etc. (5s.); (4) bolts, nuts, rivets, etc. (10s.); (5) flanged copper plates, copper rods and ingots (£1); (6) platelayers' tools (2s. 6d.); (7) cast-iron, pot sleepers (£1); (9) gibs and cotters (2s. 6d.); (10) steel fishbolts, chairbolts, etc. (7s. 6d.); (11) crank-axles (10s.). The Company's Offices. (Fees non-returnable.)

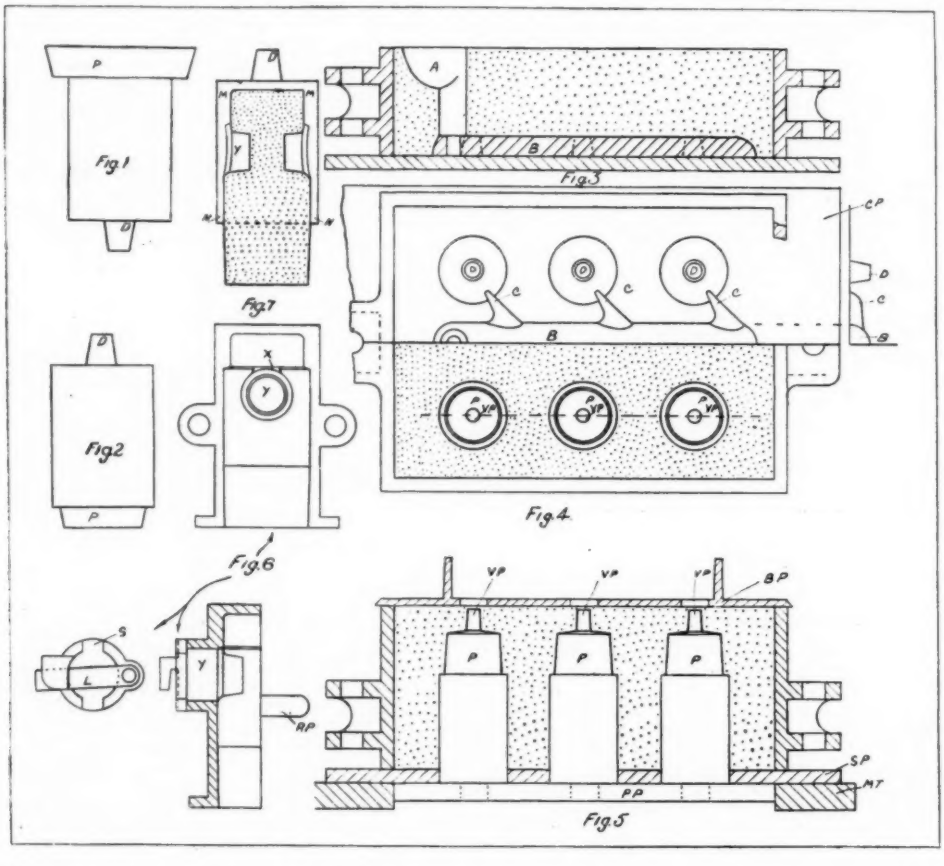
Small Piston Castings

By ECOSSAIS.

Opinions differ as to the best way to cast small pistons, some preferring to use a pattern as shown in Fig. 1, the core being supported in the large print, others choosing a pattern as shown in Fig. 2. The advantages claimed for the former type are the ease in centreing the core and a better chance of obtaining a clean casting. Theoretically, the method of centreing approaches perfection, but in practice does not prove so, there being too many variable factors at work to obtain consistently good results. With a wood pattern, swelling of the print occurs, and this results in too much play for even a perfect core. Swelling of a wooden core-box increases the play in the print, and variations in the sizes of cores occur, due to the core-oven temperature. Cores that do not touch the top box all round may be lifted up on one side, and thus give an eccentric core. The claim for obtaining a clean casting by casting head down is not proved, and if precautions are not taken to prevent dirt entering the casting, the casting is almost certain to be dirty Were the casting an inch or more in thickness when machined and the metal cast hot, the claim would probably be upheld, but with small pistons the thickness is not usually expressed in inches, but in millimetres. Actually, dirty castings, are not the chief cause for scrapping pistons of small size, the cause being more often small air-holes, eccentric cores, and sponginess near the bosses.

The arrangements made by the writer for producing a large quantity of small pistons are shown in Figs. 3, 4 and 5, use being made of two small machines of the Pridmore type not otherwise in use. In Fig. 6 are shown three views of the core-box, made in halves and with loose bosses *Y* arranged with projections *S* so as to fit only one way, although each would fit either half of the box, and held in position by a spring latch *L*. It was found to be necessary to fill in the small space immediately above the boss, at *X*, in order to prevent sponginess by the creation of a hot spot at this point. In use, the core-box was assembled, the bosses being held firm by the catches *L*, the two halves being held together by two cotters, in pins *RP*, not shown in the drawing. After ramming, striking off and venting, the box is turned over, rapped lightly with a small mallet, the two latches *L* knocked down, and the bosses drawn. The cotters in the pins *RP* were removed by a light downward blow with the mallet, when the two halves of the core-box were removed, leaving a perfect core. Although not absolutely necessary, the bosses are worked loose in order to avoid the ragged edges left by a bad draw with fixed bosses, so that touching up was unnecessary, the only tools used being a rammer, small trowel, vent wire and a mallet, the box being wiped out occasionally with a piece of waste, moistened in paraffin oil.

The sand for the cores is carried on a raised shelf on the back of the core-bench and drawn off into the core-box as required. The working-bench face is perforated, a ramming plate about 12 in. sq. being used. Any excess sand falls through the perforations, instead of littering the bench and burying the tools. The cores, after drying, are blacked by dipping whilst still warm into a small pail containing blacking of medium thickness, being held by the print end, which is left bare. After a plateful have been thus blacked, and before replacing in the oven, any "drops" of blacking left on the core through dripping are easily removed by a brush dipped in water.



In making, a number of drags or bottom parts are prepared first, being rammed up as shown in Fig. 5 with a bottom plate *PP*. In addition to the core-prints *P*, a small peg *VP* is provided, the bottom plates having holes in a corresponding position. The patterns are drawn by lowering the plate *PP* carrying the patterns through the stripping plate *SP* which sits on the machine table *MT*. When the mould is removed from the machine it sits on the plate, clear of the floor, due to the supporting ribs which allow the vent from the cores to escape freely.

In Fig. 4 is shown a half-plan of the drag mould showing the vent outlets *VP*. The cores are usually so well fitting that, when in place, the drags can be turned over without any risk of the cores falling

out, the taper of the prints *P*, which are 1½ in. in length, being only about 1mm. each side. The upper half-plan shows the cope pattern-plate *CP* carrying the gate, consisting of a channel *B* and ingates *C*, also the pegs *D* cast-on for machining purposes. A part half-elevation shows the relative sizes of *B* and *C*. In this view of the cope pattern-plate the relative position of the drag mould is shown by a full line indicating the extent to which the ingates *C* overlap the mould space; also the recess in *B* for insertion of the gate-pattern *A* shown in Fig. 3.

Fig. 3 shows a section of a cope rammed up and sitting on the machine. In this case no stripping plate is necessary, the pattern-plate being simply drawn down, leaving a clean mould. In each case, both cope and drag, finishing of the mould is dispensed with; no blacking is used, and with the exception of the small gates *C*, which are ground off, the castings are dressed by the tumbling barrel.

Fig. 7 shows a section of a core and mould space. Owing to the heavier section of metal at *M* as compared with that at *N*, this part of the casting will remain fluid longer, so that if cast head down there is a great probability of the metal in the bosses being drawn upon to feed the thick section *M*, this being also in a position in the mould liable to keep hot.

By reversing and casting as described, head uppermost, although not producing exactly ideal cooling conditions, these conditions are such as to compensate somewhat for the difference in thickness. It is rather significant, however, that in actual practice and using the same metal apparently, the number rejected for small pinholes showing up after machining, and drawn bosses, was considerably reduced by casting head uppermost as shown. Attention is drawn to the small ingates which were purposely made so small as to prevent pouring if the metal was not extremely hot.

Even with very hot metal there is a sudden check as the channel *B* gets full, the mould filling quite slowly, and probably in this manner allowing the gases and air to escape more freely from the large opening under the core.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Cupola Troubles.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—S. C. B.'s idea for cupola receiver, as set out in a recent Foundry Query, connection regains is good, and he should encounter no difficulties in this respect. In regard to his proposal for relining, most modern cupolas, above 5 tons capacity, especially those having automatic charging chutes, have hollow cast-iron bricks opposite the charging door, and extending round half the circumference of the cupola to a depth of 3 or 4 ft.

Care should be taken that these bricks be keyed horizontally and supported by a cast-iron flange rivetted to cupola shell. For a hand-charged cupola, these bricks are not necessary, as they are only there for protection against the battering effect of the charges. With respect to relining the lower part with ganister material, provided a sufficiently refractory material is obtained, and a cheap method of ramming the cupola adopted, an ideal lining, absolutely free from joints would be obtained. Ordinary ganister by itself will not do as far as its refractivity is concerned, and a material having a high SiO_2 base would have to be adopted. The best material on the market at present is one much advertised in this JOURNAL. Two methods are in use for relining with refractories:—(1) Using a pattern and ramming direct in cupola. (2) Making bricks by hand moulding, and fitting same as firebricks.

A good ganister mixture for making bricks is as follows:—Ganister, 40 per cent.; crushed old firebricks, 40 per cent.: coke breeze, 10 per cent.: and fireclay, 10 per cent. This should be mixed in a light pug mill for 10 minutes.

These methods have been tried, but have not stood up as well as firebricks for modern cupola wear and tear.

Yours, etc.,
"INTERESTED."

SIR,—With reference to S. C. B.'s query, bearing the above caption, I agree with him that it will be a wise plan to make a loose top for the receiver. I recently carried out such an operation but experienced trouble because the top was too light. This was overcome by making the top about 3 in. thick and bedding it down with ganister. This cover was about a foot larger than the diameter of the receiver (32 in.). Though in my case the cover is removed by pulley block gear, I suggest a lever arrangement could be incorporated.

I do not care for the system of having metal bricks in the cupola, as they retain the heat and make daubing a more uncomfortable job than normal. If the cupola is blowing daily and further metal bricks will melt when blowing down. I advise that S. C. B. insists that his cupola man drops the charge straight down the cupola instead of standing a yard away and throwing it against the side. Dropping the charge instead of throwing it prolongs the life of the cupola and economises coke, because it prevents scaffolding or hanging charges.

Careful daubing, in my case, has allowed a cupola to run for over twelve years without re-lining. It is a 50-in. shell lined to 30 in. furnace, and it casts five days a week, making on an average 30 tons per week.—Yours, etc.

T. D. (Manchester).

Pearlitic Cast Iron—Criticisms Examined.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The question you ask in the editorial article of July 5, under the above heading, is, as you admit, rather involved. My previous contribution was not intended as an answer to such a question, and my real contention was, that a high pearlite content was only of use when combined with other structural characteristics, the chief of which is the requisite fineness of the graphitic carbon. A pearlite-graphite structure is undoubtedly the one to aim at, for strength in ordinary sand castings, but the graphite must be the right type. It generally happens that in cupola-melted strong cast iron sulphur runs fairly high, say 0.10 to 0.15 per cent. If balanced by a suitable amount of manganese and poured sufficiently hot this is no detriment. Whether it is or is not, a necessary adjunct to a pearlite-graphite structure is another matter. My own view is that it is an incidental feature of cupola melting, which must be suitably provided for. It would certainly be interesting to know how closely mechanical properties follow pearlite content in irons of otherwise similar composition and correct graphite formation. The standardisation of the latter is, however, necessary in the first place. By a backward process of reasoning there is evidence that given graphite of the requisite degree of fineness, the pearlite content has comparatively little effect on the mechanical properties. I refer to Mr. Broughall's paper on "Denseness and Permanent Moulds" in the 1918-1919 proceedings of the I.B.F., pages 79 to 81. The soft cast iron (Si 2.77 per cent) cast into 1¼-in. bars in permanent moulds gave, on 0.564 in. dia. test-bars, a tensile strength of 15.2 tons per sq. in. Bars cast of same metal, and annealed at 800 deg. C., gave just over 17.0 tons per sq. in. The combined carbon figures were: As cast, 0.63 per cent.: annealed, 0.19 per cent. The chief characteristics of permanent mould castings are:—

(1) Very fine graphite, definite flakes being almost suppressed.

(2) A decided network formation of any phosphide that may be present.

Personally I place most importance on the former.

In ordinary sand castings the reduction of combined carbon, or pearlite content, by annealing, results in a distinct loss of strength. In this case of permanent mould test-bars we have a distinct gain in strength, with a lowering of pearlite content. Considerably more study is evidently still necessary of the relative influences of pearlite and graphite on the mechanical properties of cast iron.

Yours, etc.
HILTON MILLS.

Stocks, Middleton, Manchester.

Estimation of Phosphorus in Iron and Steel suspected of containing Tungsten.

By "CELSIAN."

Although the presence of tungsten is suspected in iron or steel under examination, many chemists still estimate the phosphorus by the ordinary direct method.

That this is an error has been pointed out on many occasions by different authorities.

In separating the tungstic acid by evaporation to dryness with hydrochloric acid, a large proportion of the phosphorus is precipitated together with the tungstic acid in the form of phospho-tungstic acid, so that the results secured by this method are very low.

Research work has been conducted on the accuracy of the estimation, and the conclusion drawn was that at least twice as much phosphorus was contained in the tungstic acid residue, as was left in the filtrate.

The process then proposed, although accurate, was a little too prolonged and tedious to perform if, eventually, it is found that little or no tungsten exists.

At the present time no particularly rapid direct test can be made to ascertain if tungsten is present, so that time is lost at the commencement of the analysis in making a preliminary qualitative examination.

When dealing with metal of uncertain composition, provision should be made for testing for the presence of rarer metals during the ordinary course of quantitative analysis.

The same applies to an even greater extent to the analysis of ores containing phosphorus and tungsten.

In the following description details are given of how phosphorus may be determined in iron or steel, and the provision made when it is found that tungsten also is present.

Method Suggested.

One gram of the sample is weighed into a 20-oz. beaker and dissolved in strong nitric acid.

The liquor is evaporated to dryness, and the residue baked on a hot plate which converts the ferric nitrate to oxide of iron. If this baking has been properly conducted little difficulty should be experienced in removing the solid matter from the beaker.

The mass is transferred to a platinum crucible and thoroughly mixed with 5 grs. each of potassium nitrate and sodium carbonate.

Before fusing the mixture, it is advisable to heat the crucible on the top of the muffle for a short time as there is a risk of some getting lost if placed directly inside the hot furnace. It is then laid on a small fireclay rest inside the furnace and allowed to fuse for about thirty minutes.

The molten mass should be quite tranquil before removing from the heat. When cold, the fused mass is dissolved out of the crucible, using as little water as possible.

The liquor is filtered and washed with boiling water containing a little ammonium nitrate until the paper is free from salts.

Hydrochloric acid is added to the filtrate in sufficient quantity to make the solution distinctly acid, and then a few drops of bromine poured in until a permanent colour is produced.

After standing a few minutes, a large excess of strong ammonium hydrate is added, and after cooling the solution, phosphorus is precipitated by addition of magnesia mixture. The liquor is thoroughly stirred up and allowed to settle overnight.

This precipitate, besides containing all the phosphorus present, may also contain tungsten, and where ores are dealt with, arsenic and tin will also be deposited. The solution is filtered, using double filter papers and washed with dilute ammonia. A few drops of strong hydrochloric acid are poured over the filter which dissolves the precipitate, the rich liquor being collected in a pear-shaped flask. As little acid should be used here as possible, since the solution is to be evaporated to dryness.

A few crystals of potassium chlorate are added and the liquor boiled, which is now thoroughly oxidised.

A clean piece of metallic zinc is introduced to the solution, which produces a bright blue colour if tungsten is present. This colour is characteristic of tungsten when phosphoric acid is present.

If no colour is formed the percentage of phosphorus present may be ascertained without further delay, by removing the zinc and titrating the solution with a standard solution of uranium acetate, using potassium ferrocyanide as indicator.

When a black or dark deposit separates out from the liquor (in the analysis of ores), this is probably due to the presence of arsenic and tin.

In the latter case the zinc must be allowed to lie in the warm solution until no further deposition occurs, after which the precipitate is filtered off and washed. If this filtrate is free from any blue coloration, the uranium acetate titration may be applied.

When a rich blue colour has developed the zinc is removed and the small solution evaporated to dryness.

The residue is dissolved in about 10 c.c. of hydrochloric acid, diluted, and a current of sulphuretted hydrogen gas passed in. The precipitate is filtered off, washed, and the filtrate boiled till free from the excess of gas.

Ferric chloride is then added, or a few pure iron filings, together with a little nitric acid used, and the solution oxidised with nitric acid. A large excess of ammonium hydrate is added, the liquor well shaken up, and the bulky precipitate of ferric hydrate containing the phosphorus filtered off. Another method consists of adding ammonium hydrate to the unoxidised solution until a distinct dirty greenish-coloured precipitate is formed.

This is acidified with acetic acid, which dissolves the ferrous hydrate, and on boiling basic ferric acetate is precipitated containing all the phosphorus, which is then filtered off.

The ferric hydrate, or ferric acetate precipitate is redissolved in nitric acid and an excess of ammonium molybdate added.

Ammonium phospho-molybdate is either collected on a tared paper and weighed, or filtered through pulp and titrated by one of the usual volumetric methods. The advantage gained by adopting the foregoing method of adding zinc during the analysis will be readily observed by those who have metal of uncertain composition under examination.

It saves a considerable amount of time to the operator, as he can tell whether there is sufficient tungsten present to interfere with his phosphorus determination or not, before proceeding further with the latter part of the analysis.

American Trade Practices for Electric Steel Castings.

The following "Customs of the Trade" have recently been adopted by the American Electric Steel Founders' Research Group.

1. Suitable pattern equipment for economical moulding shall be furnished by customer.

2. The foundry will not be responsible for correctness of pattern equipment to blueprint, except when such equipment is made for the customer under the supervision of the foundry.

3. Repairs on pattern equipment shall be paid for by the customer, except when occasioned by carelessness on the part of the foundry.

4. Patterns must have distinctive colours to identify separately the core-prints, machined surfaces and rough casting.

5. All patterns, coreboxes, and loose pieces thereof must be properly numbered for identification.

6. All transportation charges on pattern equipment to and from foundry shall be paid by the customer.

7. The foundry will not carry insurance on customers' pattern equipment.

8. Free replacement will be made of defective castings if reported and returned to foundry within a reasonable time.

9. The foundry will not be responsible for any expense on defective castings incurred by the customer.

10. The customer will be charged with the cost of moulds and cores discarded by the foundry, due to change in patterns or coreboxes.

Protection of the Eyes in the Iron and Steel and Foundry Industries.

BY ANEURIN RHYDDERCH, B.Sc.

In a recent report of the Eyesight Conservation Committee it is stated that 75 per cent. of the annual roll of eye accidents might be prevented by methods which have already proved their efficacy. This is a regrettable state of affairs, and arises in all probability from ignorance of the existence of protective glasses for the eyes, and in other cases, to the dislike by workmen to wearing glasses owing to discomfort due to bad fit, the occurrence of headaches, and the fear of splinters. Unfortunately a large percentage of their complaints are well founded. In the issuing of glasses to employees not sufficient allowance is made for the differences in configuration of various faces, with the result that though one in ten may be a good, comfortable fit, the others are painful to wear.

When the wearing of glasses causes headaches, it can safely be assumed that either the glass is badly finished or the user has defective vision. Generally 50 per cent. of industrial workers, more or less, have defective vision. It naturally follows that all men called upon to wear goggles should have their eyes tested, and lenses made up to suit them. One engineering firm doing a large amount of fine work tested the eyes of all employees, with the result that glasses were prescribed for 83.3 per cent. The result was an increase in production of 28 per cent.

There is also the question of glasses breaking and splintering, but with properly selected glasses this danger does not exist, because modern glasses for preventing flying chips from injuring the eye will only crack when struck, owing to their special resilient and tough nature.

Having briefly mentioned a few general points about goggles, it is natural to ask what are the possible causes of eye accidents in the iron and steel and foundry industries. Firstly, there is the danger of splashes of molten metal during casting operations; secondly, the danger of flying chips in the dressing or fettling of castings; lastly, the invisible but very dangerous rays emitted in all high-temperature work, particularly in operations where an arc is employed. These rays are called "infra red" and "ultra violet."

Metal Splashes.

As regards splashes of molten metal, it is well known that some varieties of glass will not stand heat, and in view of the high temperatures of the molten alloys and metals used, it is therefore essential that the glasses used should be so selected as to protect the user from this possible source of injury. It has been suggested that a suitable test would be the dropping of 5 grammes of molten lead three times on each lens selected for test, from a height of 18 in., no piece of glass to leave the frames under the test. Glasses have already been supplied to this specification. This seems a very lenient test from the standpoint of those engaged in the iron and steel industry, and it would be more serviceable if the temperature of the metal used for testing were fixed at 1,000 deg. C. Even then it would not approximate to iron and steel and foundry conditions.

For adequate protection from flying splinters, the workman should be equipped with the "Triplex" type of glass, which can be made up to any medical prescription. This is made up of two layers of glass with an intermediate layer of celluloid or xylonite, and has the property of not flying to splinters when struck. During the war it was used by members of the Royal Air Force for eye protection, and has since been used very successfully as wind screens on motor cars. To ensure the purchase of satisfactory glass to withstand flying splinters, a small drop test is suggested such as a 100-centimetre (say 40-in.) drop ten times on 10 per cent. of the lenses, using a 2-centimetre (0.8-in.) ball about 20 grammes (0.7 oz.) in weight; in addition, a maximum allowance for variation in thickness should be fixed for plain lenses. This would ensure worked glass of the necessary toughness.

As to the third and last cause, namely, the invisible but dangerous "infra red" and "ultra violet" rays, very little attention has been paid to the dangerous effect of rays emitted in all high-temperature work. The fact that these harmful rays are invisible, and that their action is cumulative, probably accounts for this.

When a source of light—such as that produced by an arc—is examined by a spectroscope, we get what is called a "spectrum." In the case of sunlight, this is similar in effect to that of the rainbow, which, as is well known, is simply the components of white light resolved by means of rain drops. It will be seen, therefore, that any source of light can be resolved, and the intensity of the various components measured by suitable means. The various components are generally referred to in terms of "wave lengths," the visible spectrum ranging from 3,900 Angstrom units in the case of violet, to 7,500 Angstrom units in the case of red (see Fig. 1).

Beyond the violet end—that is, below 3,900 A.U.—we get the "ultra violet" rays; beyond the "red end"—that is, greater than 7,500 A.U.—we get the "infra red" rays. Although both types of rays are invisible, they can be easily and accurately measured by physical apparatus.

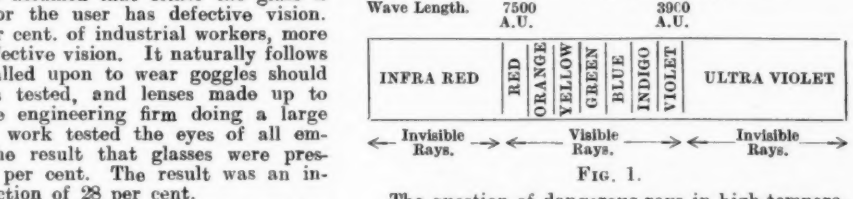


FIG. 1.

The question of dangerous rays in high-temperature work has been investigated by a committee of the Royal Society in connection with glass blowers' cataract, and in their report, which dealt with temperatures up to 1,500 deg. C., it was stated that the requirements for suitable glass were as follows:—(1) Absorb "infra red" rays; (2) absorb "ultra violet" rays; (3) a uniform absorption of the visible spectrum so that colour shall not be distorted; (4) reduction of glare. To these requirements must be added the ability to withstand splinters and molten metal.

Sir William Crookes carried out a prolonged research on glasses suitable for eye preservation, and found that a glass containing cerium oxide cut off all the "ultra violet," most of the "infra red," and transmitted 98½ per cent. of the visible spectrum. But this glass is practically colourless, and does not therefore meet our requirements. There are, however, a few special glasses on the market, such as "Akopos," which are stated to meet the requirements of the specification as laid down by the Royal Society. This glass is greenish-yellow in colour—the ideal colour for causing the minimum distortion; further, the relation of intensity to temperature appears nearly the same as to the naked eye, which has a maximum degree of sensitiveness in the central yellow green. These glasses have been tried by various persons engaged in high-temperature work, and in each case the report has been favourable. But it is obvious that glasses such as these, which are of a totally different colour from the cobalt-blue glasses now generally used in foundries, could not be introduced immediately. Much remains to be done in the production of the ideal glass for use on high-temperature work. The chief point to bear in mind is that the colour must be easy to duplicate—this is in addition to the other properties it must have, and which have already been enumerated.

In the case of the various existing users of blue or smoked glasses, it is suggested that glasses of the Crookes type be combined with the present ones, thereby cutting out the dangerous rays.

Exhibition of Engineering Models.—In connection with the Conversazione held at the Institution of Civil Engineers last Thursday, the usual exhibit of engineering models and scientific apparatus was arranged. There were large numbers of exhibits, including a Cambridge stress recorder and a stress indicator; fractured specimen of spline shaft from motor lorry, showing the effect of sharp corners; tensile-test bar from broken drawbar hook, showing "Luder" lines; level for machine-tool builders; model of new type of locomotive drive; air-lubricated vertical Michell thrust bearing; specimen and test-pieces in connection with experiments on the corrosion of metals.

The Recovery of Brass from Foundry Refuse.*

By C. S. Parsons.

There are many brass foundries in the cities and larger towns of Canada in which a considerable quantity of refuse is collected at intervals, and sold to United States points, where it is treated for the recovery of the brass; or the slag is broken up and the larger pieces hand sorted out, the remainder being discarded as useless. The shipment of this material to points outside the country brings little return after freight and treatment charges are deducted. In many cases the refuse could more profitably be treated at the foundry by the installation of a small plant. It was for this reason that the following test work was conducted.

A shipment of 16,520 pounds of foundry slag and sweepings was received at the Ore Dressing and Metallurgical Laboratories on May 4, 1921, from Mr. S. R. Francis, of the Ontario Specialties, Limited, Ottawa, Ont.

Test work was desired on this shipment to obtain a separation of the metal from the slag in as coarse a form as possible, and to determine a simple flow sheet for the recovery of the metal from the slag and sweepings.

The slag was fed directly to a 4 ft. 6 in. Hardinge mill, containing a ball charge of 2,000 pounds. It was crushed wet, and the pulp from the mill fed to a standard size Wilfley table equipped with a No. 1623 deck, without being sized or classified. Only the very fine brass was discharged, the coarse metal remaining in the mill. After running for some time with an unclassified feed to the table, the discharge of the mill was run into a Richards launder classifier, and two products were made and fed separately to the table. The classified feed gave the better results, a lower tailing being produced, and the concentrate was cleaner.

At the end of the test the Hardinge mill was cleaned out and it was found that the major portion of the brass, consisting of the coarse pieces, remained in the mill. The clean up of brass from the mill, weighing 1,766 pounds, was dried and passed over a magnetic cobber, removing 100 pounds of iron, and leaving 1,666 pounds of coarse brass metal.

The table concentrates were dried, weighed, and passed over a magnetic cobber, removing 356.5 pounds of magnetic material, leaving 887 pounds of fine brass.

The following table gives the weights and analyses of the products from the shipment:—

Products.	Weight pounds.	Analysis.			
		Cu.%	Pb.%	Zn.%	Sn.%
Coarse metal from clean up of ball mill ..	1,666.0	79.0	7.8	2.0	11.0
Iron removed from clean up of ball mill ..	100.0	—	—	—	—
Fine metal from table concentrates ..	887.0	82.05	4.5	6.13	6.2
Magnetic products from table concentrates ..	356.5	22.85	—	—	—
*Tailings from table ..	13,510.5	3.20	—	—	—
Total	16,520.0	15.5	—	—	—

*NOTE.—Tailings from unclassified feed gave an analysis of 3.80 per cent. Cu.

Tailings from classified feed gave an analysis of 2.70 per cent. Cu.

Conclusions.

No particular difficulty was experienced in the separation of the metal from the slag. The metal obtained was a high grade product, suitable for re-melting.

For the small brass foundry, a simple equipment of a small size Hardinge mill, and a half-size Wilfley table, would be sufficient to handle the slag and sweepings.

Export of Ukrainian Ore.—Owing to the fact that the Russian blast furnaces are consuming only small quantities of ore, the Ukrainian People's Economic Council has decided to help the export of iron and manganese ores as far as possible. Old stocks of ore which have accumulated since before the war are to be exported at prices below present market quotations. It is proposed to liquidate Exportruda (the company for ore export), as it has not worked economically, and to entrust the Southern Ore Trust with the export of ores.

* Summarised Report—Mines Branch of the Canadian Department of Mines.

A New British Industry.

Since the war a new industry has been built up by Messrs. Fescol, Limited, of 3, Penarth Street, London, S.E.15, which basically consists of depositing nickel on worn metal parts. The process exploited is an adaptation of nickel plating, but differs from it in the mechanical results obtained, mainly those associated with stripping and peeling. That the deposited nickel is both strong and tough is shown by a test carried out by the National Physical Laboratory, in which a nickel-coated cylinder had the nickel-deposited portion provided with a 40 per in. thread. This was screwed into a mild-steel bushing and tensile stress was applied to the joined piece. The thread of the mild-steel bushing broke down at 6.74 tons, clearly indicating that the nickel coating firmly adheres to the mild steel and, secondly, that the deposited-nickel thread was stronger than the mild-steel thread. New commercial applications for this process are being discovered every day, and amongst those noted during a visit by our representative were: (1) Crank shafts, in which the bearings, threads, and machined surfaces were being rebuilt, ground, and machined to size. (2) Pistons being built up on the skirt, glands, gudgeon pin holes, and in the grooves. (3) Valves on the stems. (4) Tappets on the shaft or shanks. (5) Cam shafts on bearings, gear wheels, and cams, and (6) armature shafts were being built up on the steel parts without disturbing the windings.

Of interest to foundries is the application to castings which after machining are found to be just under size, then anything up to an eighth of an inch can be deposited and so salve a waster. As nickel is inoxidisable, it presents many added advantages. The largest bus company in London and other equally important firms are increasingly availing themselves of the facilities afforded by the possibility of what can be described the "putting-on" tool of the engineer.

Increasing Trade Competition in Portugal.

His Majesty's Consul at Lisbon (Mr. S. G. Irving), in reporting to the Department of Overseas Trade on the Portuguese trade in foreign textiles, states that while the United Kingdom continues to secure the greatest share of the trade, certain of our chief competitors are advertising very freely, making use for this purpose of catalogues and other literature printed in Portuguese. The Consul accordingly suggests the wider use of similar methods by British firms, especially as trade literature printed in Portuguese might at the same time serve to cover the important Brazilian market.

Applications for Trade Marks.

The following list of applications to register trade marks is extracted from the TRADE MARKS JOURNAL:—

HEXAGONAL NUT (DESIGN) INSCRIBED "REX."—Metals. Paul Ludwig Krönke, c/o W. H. Beck & Company, 115, Cannon Street, London, E.C.4.

"MICRO."—Driving gear for lifts, elevators, etc. Waygood-Otis, Limited, 54 & 55, Fetter Lane, London, E.C.4.

"DIAMANTE."—Galvanised iron and steel sheets. Albert Coates & Company, 3, Gore Street, Manchester.

KIWI (DESIGN) AND "KIWI."—Tinplates. Cyril W. Massey & Company, Limited, 88, Gracechurch Street, London, E.C.3.

"REGATTA."—Metal goods. Septimus Vaughan, Limited, Staffordshire Edge Tool Works, Henry Street, Swan Village, West Bromwich.

"WELDROPS."—Electrodes. Weldrics (1922), Limited, Bush Lane House, Bush Lane, Cannon Street, London, E.C.4.

"PERCLAR."—Metal goods. Percy Clark & Company, White Horse Yard, 16, Coleman Street, London, E.C.2.

"STRONG-ARM."—Pneumatic machinery and machine tools. Sir W. G. Armstrong, Whitworth & Company, Limited, Elswick Works, Newcastle-upon-Tyne.

Some Experiments on the Malleablising of Cast Iron.

In recent issues of "Stahl und Eisen," P. Oberhoffer and J. Welter describe some investigations carried out with a view to determining the part played by sulphur in the malleablising process. The oxidised marginal layer or "skin," which is so troublesome in the manufacture of malleable castings, was also investigated.

Experimental Data.

The experimental iron was made in a Krupp cryptol furnace. The analyses of the material are given in Table I. Owing to the higher percentage of manganese in casts Nos. 5 and 6 the sulphur is presumed to be present in the form of manganous sulphide, whereas in the remaining samples it is in the form of iron sulphide. From each melt four bars of about 10 in. (25 cm.) long and 8 × 16 mm. cross-section were cast in a vertical sand mould. One bar was broken in the middle, when were taken the samples used for the microscopical and chemical analyses. All the samples were free from graphite.

TABLE I.—*Chemical Composition of Samples.*

Cast. No.	S. Per cent.	C. Per cent.	Si. Per cent.	P. Per cent.	Mn. Per cent.
1 ..	0.129	2.78	1.05	0.032	0.128
2 ..	0.156	2.96	0.96	0.032	0.126
3 ..	0.359	2.78	1.06	0.032	0.124
4 ..	0.014	2.78	0.87	0.035	0.343
5 ..	0.330	2.60	0.95	0.035	0.403
6 ..	0.370	2.44	0.79	0.035	0.567
7 ..	0.211	2.70	1.14	0.032	0.124

The remaining test bars from each melt were annealed in three different ways. Fig. 1 gives

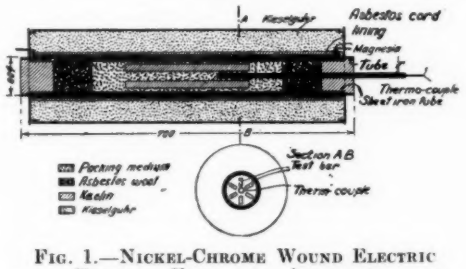


FIG. 1.—NICKEL-CHROME WOUND ELECTRIC FURNACE USED FOR ANNEALING THE SAMPLES.

the details of the electric furnace used for annealing, as well as the other test arrangements. The temperature was kept satisfactorily constant during the malleablising process.

The three malleablising tests were carried out under the following conditions:—

Fig. 2 shows the temperature curves obtained with a recording pyrometer.

TABLE II.—*Conditions of Annealing.*

	Temperature deg.C.	Time in hours	Packing medium.	Effect.
Test a.	900	60	Mill scale dust, shifted	Weak.
Test b.	910	60	Red hematite, size of grains 2 to 4 mm.	Strong.
Test d.	1,030	70	Mixture of 1/3 fresh mill scale, 1/3 used mill scale, 1/3 fresh red hematite.	Medium

NOTE.—In test "d" the furnace burnt out after 30 hours. Before the test was continued a sample of each of the melts was taken for studying what had happened during this period. These samples are marked "c."

Notch impact and tensile test bars were taken from the annealed samples, the notch-impact test pieces being 110 mm. long with a 2 mm. dia. round notch, the distance between centres being 80 mm.

The tensile test results are not given, as the effect of the various factors to be determined was

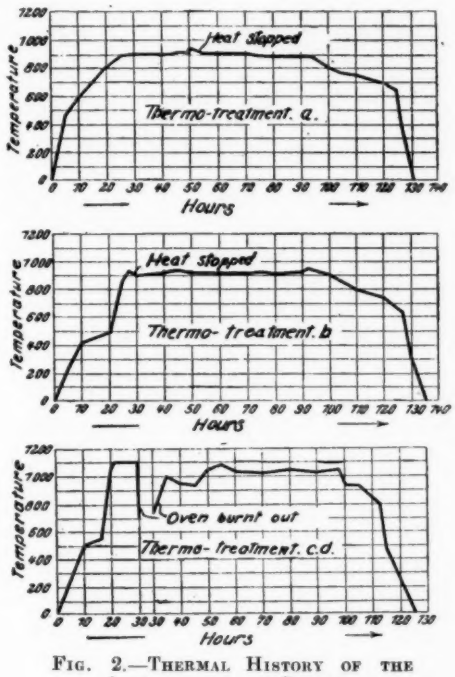


FIG. 2.—THERMAL HISTORY OF THE ANNEALING OF THE SAMPLES.

masked to a certain extent by faults in the material.

Tests Results.

The curves in Fig. 3 show (1) the notch-impact strength decreases with increasing sulphur content. (2) When using the packing medium marked "strong" (red hematite), the notch-impact strength, under otherwise equal conditions (900 deg. annealing temperature for 60 hours) is higher than where the weaker packing medium is used (mill-scale. (3) By raising the annealing temperature,

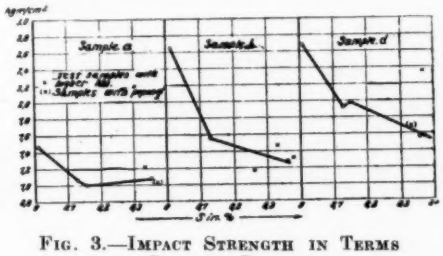


FIG. 3.—IMPACT STRENGTH IN TERMS OF SULPHUR CONTENT.

a further increase in the notch-impact strength is obtained by using a medium packing compound, this strength being higher compared with that obtained with the strong packing medium, and varying in direct ratio to the sulphur content. This confirms the fact that cupola-made castings must, owing to their higher sulphur content, be annealed at a higher temperature where increased toughness is desired. (4) The manganese equalises the effect of the sulphur, inasmuch as 0.5 to 0.6 per per cent. Mn with 0.35 per cent. sulphur gives the same notch-impact strengths as correspond to an average of only 0.15 per cent. in castings that are practically free from manganese.

Sulphur and Carbon.

In order to ascertain whether the influence of the sulphur is indirect in the sense that its presence affects the form and quantity of the carbon, the malleablised samples were chemically analysed for

total carbon, temper carbon and combined carbon. The results are plotted in Fig. 4 in terms of sulphur content.

It will be seen from Fig. 4 that there is no appreciable difference betwen the results of sample "a" and "b." In these two series of tests the total carbon seems gradually to increase with increasing sulphur content. The presence of sulphur thus hinders the decarburisation, either because the flow of carbon outwards is retarded (Ledebur); the sulphur inclusions acting as obstacles; or because sulphur prevents dissociation of the temper carbon, and consequently its gasification (Wüst). The quantity of combined carbon remains constant from 0.1 per cent. sulphur, while

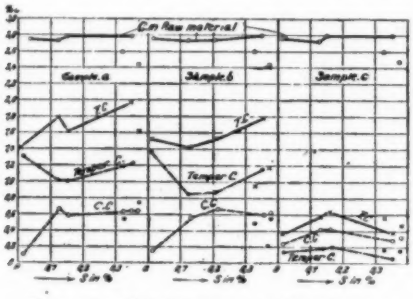


FIG. 4.—CONDITION OF CARBON IN TERMS OF SULPHUR CONTENT.

the temper carbon from this sulphur content onwards increases practically proportionally to the total carbon content, the temper carbon forming from 60 to 65 per cent. of the total. In the low-sulphur sample No. 4, the major proportion of the carbon in both test series is present as temper carbon. It is very probable that there is an abrupt change in the effect of the sulphur between 0 and 0.1 per cent. S, the quantity of combined carbon increasing five- or sixfold. This is probably due to a certain solubility of sulphur in the solid iron.

The sulphur present in the solid solution would not effect the permanence of the carbide, whereas if segregated, the sulphur would cause a certain amount—independent, within fairly wide limits, of the sulphur content—of carbon to be retained in the combined form.

Influence of Temperature.

Of much greater effect than that of the packing medium is the effect of the temperature. Fig. 4 shows that even after tempering or malleabling ten hours at 1,030 deg. C., the total carbon is as

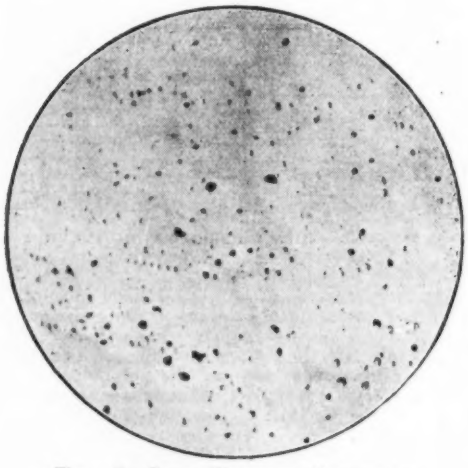


FIG. 5.—IRON SULPHIDE INCLUSIONS ON UNTREATED SAMPLE NO. 2 (×400 DIAS.).

great as when the material is malleablised for six hours at 900 deg. C. In the series "d," the decarburising effect masks all other effects. Further, there is a fundamental difference between the test series "a" and "b" on the one hand and "d" on the other, in that in the former the cooling was carried out very slowly down to 650 deg. C., whereas in the latter series the slow cooling was carried only down to 780 deg. C., cooling subsequently proceeding comparatively quickly, because the oven gave out. There is no doubt about it that the rate of cooling has an effect on the ratio of the temper carbon and combined carbon to the total carbon.

Influence of Manganese.

In test "d" the behaviour of the samples containing manganese scarcely differs from the manganese-free samples, whereas in test series "a" and "b" the quantity of total carbon and temper carbon is appreciably lower than it is in the low-manganese samples.

The quantity of combined carbon is not, however, affected by the manganese content. One might be inclined to attribute the lower total carbon and temper carbon contents to the slightly lower percentages of carbon in the unmalleablised material. The result would be that slight changes in the original carbon content would exert considerable influence on the result. A more likely explanation is that iron sulphide and manganese sulphide affect in different ways the gasification of

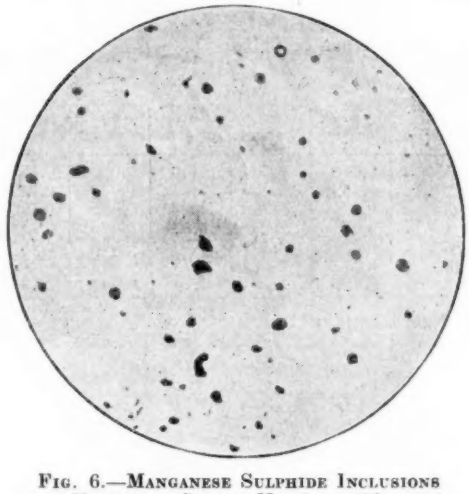


FIG. 6.—MANGANESE SULPHIDE INCLUSIONS ON UNTREATED SAMPLE NO. 6 (× 400 DIAS.).

the carbon and the processes of decarburisation, provided, of course, the annealing temperature does not exceed 900 deg. C.

Influence of Packing Media.

Although the number of shock tests carried out was small, there is scarcely any doubt that they point to the quantity of combined carbon as being the decisive factor.

With a view to obtaining information as to why the so-called intensive effect of red hematite differs from the weaker effect of the mill scale, the malleablising compounds used were tested for total iron, metallic iron and ferrous oxide. Owing to a chance and unintentional impurity of the unused red hematite, it is unfortunately impossible to compare the results. At the same time the investigation shows that valuable information can be gained in this way as to the mode of action of the packing medium.

Behaviour of Sulphur.

As regards the behaviour of sulphur in malleablising, some information is at once obtained from the investigation of a number of samples before and after malleablising, as the following table shows:—

Sample.	Percentage Sulphur before Malleablising.	Percentage Sulphur after Malleablising.
3b	0.359	0.135
4d	0.014	0.042
3d	0.359	0.240
6d	0.370	0.365

Further information regarding the behaviour of sulphur in the samples, especially its distribution, is afforded by the micro-examination. Using the Baumann sulphur test, it was found that the sulphur in the initial test samples was uniformly dis-

tributed. The microscopic examination shows the variation in colour, size and number of the inclusions of iron and manganese sulphide with the same sulphur content. Fig. 5 shows the numerous small pale-brown iron sulphide inclusion of Test 3 containing 0.359 per cent. sulphur, whereas Fig. 6 shows the less numerous but larger inclusions of manganese sulphide, of the typical dove-grey colour.

Iron and Manganese Sulphides.

The difference in behaviour of the manganese and iron sulphide in the Baumann test is interesting. In spite of the same period of reaction, the same acid concentration, and conditions otherwise equal, and particularly the same sulphur content, the silver bromide paper of the sulphur prints was coloured much darker by manganese sulphide than by iron sulphide. Obviously, the solubility of the

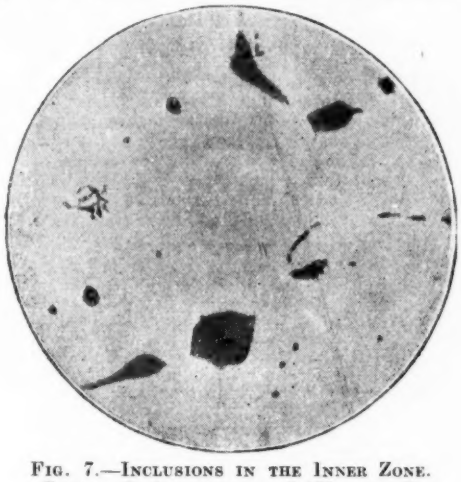


FIG. 7.—INCLUSIONS IN THE INNER ZONE. SAMPLE 3 ANNEALED AT 1,030 DEG. C. (× 400 DIAS.).

manganese sulphide in acid is greater than that of iron sulphide.

Provided the malleablising temperature did not exceed 900 deg. C., it was impossible to find any difference in the behaviour of the iron and man-

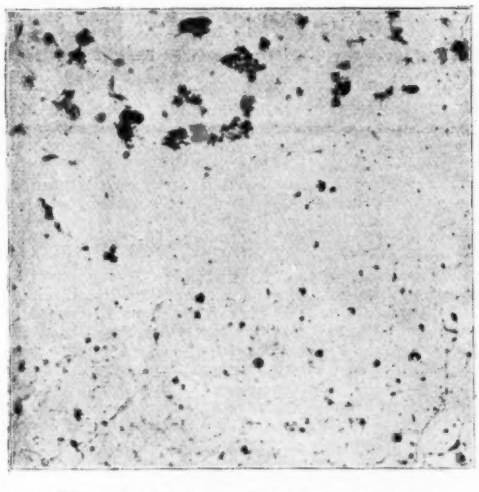


FIG. 8.—INCLUSIONS IN THE ZONES. a (INNER), b (MIDDLE), AND d (OUTER). SAMPLE 3 MALLEABLISED AT 1,030 DEG. C.

ganese sulphide in the samples, either by the sulphur print method or the micro-examination.

The samples malleablised at 1,030 deg. C. and containing manganese sulphide exhibited uniform distribution of the blackening over the whole of the cross section, and the micro-examination showed that the enclosures had remained unchanged in number and size. Where iron sulphide was present, however, the Baumann test gave the print showing three or four zones distinguished by varying sulphur content and the size and number of the inclusions. The micro-examination of these zones showed considerable variation in the size and numbers as regards the central zone, as may be seen by comparing Figs. 7 and 5 from the same sample in the central zone "b."

Balling up of Sulphide Areas.

This may be adducible to the fact that at the temperature of malleablising given, which is above that of the melting point (985 deg. C.), of the eutectic iron-iron sulphide, the inclusions are melted and flow together into larger centres. The apparently sulphur-free marginal zone in the Baumann test is shown in Fig. 8, from which its comparative freedom from sulphur may be seen. As regards the former, Fig. 9 (at same magnification as Fig. 7) shows that here, too, as in the inner zone, the sulphur has gathered into larger and less numerous centres. The impression is that the sulphur content has undergone diminution. To investigate further this point a series of sulphur determinations were carried out to ascertain the distribution of the sulphur in the marginal zone:—

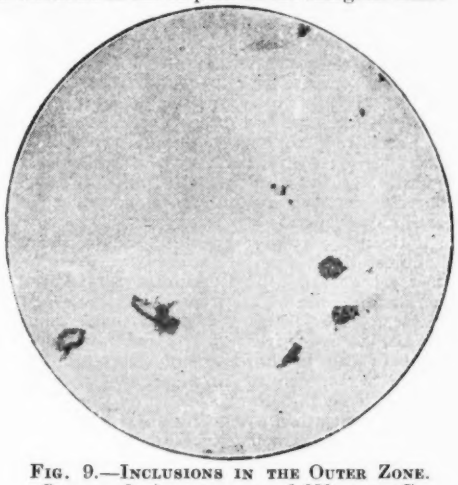


FIG. 9.—INCLUSIONS IN THE OUTER ZONE. SAMPLE 3 ANNEALED AT 1,030 DEG. C. (× 400 DIAS.).

Sample	Per cent. Sulphur in Hard Iron.	Per cent. Sulphur, after Malleablising, over the entire cross-section.	Per cent. Sulphur in Marginal Zone.	Per cent. Sulphur at the centre.
3d ..	0.359	0.240	0.124	0.311
4d ..	0.014	0.042	0.06	—

These figures show that for the high-sulphur sample, (3), the sulphur is practically unchanged in the centre zone, although the size and number of the enclosures have appreciably changed, whereas in the marginal zone a considerable decrease has taken place. The writer thinks that in view of the present knowledge of the subject it will be little use trying to find a satisfactory explanation of this typical distribution of the sulphur, and especially the sharp delimitation of the several zones, and the absence of sulphur from the zone in between the margin and centre. The state is probably due to the maintenance of equilibrium between the oxidising and diffusing effect which prevails at high temperature—a phenomenon also observed in connection with the distribution of carbon. This does not, however, account for the formation of the several zones.

(To be continued.)

COCHRANE & COMPANY, LIMITED, Ormesby Ironworks, Middlesbrough, have just secured an order from the Aberdeen Corporation for the supply and delivery of 3 miles of 48 in. diameter cast-iron pipes lined centrifugally throughout with one-inch thickness of concrete. Messrs. Cochrane recently acquired the sole rights in the United Kingdom and Ireland and certain foreign countries for the manufacture of concrete pipes by the mechanical centrifugal process known as the "Vianini" system, which is also adaptable for the lining with concrete of cast iron, steel and other classes of piping.

Book Reviews.

Refractories for Furnaces, Crucibles, etc. By Alfred B. Searle. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 5s. net.

Foundrymen buying this book must not expect any information about sands, foundry facings, or really much about crucibles, even though this is incorporated in the title of the book. One would have expected some information about the manufacture of the "pots" for steel making, especially as it is conducted in the Sheffield steel works, as the author is associated with that town.

The author has adopted the system of starting off with the finished material, and employs unusual names for common articles. For instance, one speaks of magnesite bricks, not magnesia bricks, and Bauxite bricks, not "highly aluminous" bricks. This, however, may be some phase of nomenclature of which we are unaware. The small paragraph dealing with dolomite bricks misses entirely the main point at issue, which is that in normal British climate they perish rapidly, making long transport impossible. We gather that dolomite is inferior to dead-burnt magnesite. This and numerous other statements require amplification before general acceptance, as they are only partially true. A high quality, well-burnt dolomite is often preferable to a pure or Grecian magnesite.

There is a tendency in some modern books to have innumerable short paragraphs, the length of which do not correspond with the importance of the subject dealt with. However, we presume in this case that the book is meant for students, in which case balance of importance is of a secondary character. For instance, the main feature of magnesite is its refractoriness, yet when dealing with it in the brick state only three lines are devoted to it, whilst in the raw state, five. Curiously enough, the brick paragraph states "pure magnesia has a melting point of 2,500 deg. C.," whilst the raw material section says "the melting point of pure magnesia is about 2,000 deg. C."

The most interesting section of the book is that which deals with the burning of refractory articles.

We cannot visualise the exact type of public to which the book is meant to appeal. Students should be familiar with elementary chemistry before tackling the question of refractory materials, and if they know this, then they will make better progress by starting at the end of the book and working backwards. If it is meant for users of refractories, then a reference to any particular point gives him but scant information. If he is a manufacturer, he will need a larger and more detailed text book.

Engineering Non-Ferrous Metals and Alloys. By Dr. L. Aitchison and Mr. H. R. Barclay. London: Frowde and Hodder & Stoughton, 1 and 2, Bedford Street, W.C.2. (Price 21s. net.)

One is sometimes inclined to feel that the number of books on metallurgical subjects is only exceeded slightly by the number of people engaged in metallurgical practice! Professor A, Doctor B, and plain Mr. C all feel called upon at some time or other to explain the mysteries of the arts and sciences of alloying to the enthusiastic (and sometimes indiscriminating) student. The results of their writing is often a wearisome repetition of the old basic principles unrelieved by any originality of treatment.

This certainly cannot be said of the book now under review. In the first place, it sets out to fulfil a special function. It endeavours to put down for the engineer details of those non-ferrous metals and alloys which are likely to be of use to him. By making him, in Part I. of the book, familiar with the underlying principles of foundry work and the subsequent metallurgical processes it should enable the engineer to work more in sympathy with the metallurgist.

In his excellent preface, Eng. Vice-Admiral Sir George Goodwin commends the homely language in which the book is written. It is the homely and simple treatment which makes the book of considerable use to the practical man. The chapter on the constitution of non-ferrous metals is particularly clearly set out.

As the book is, in the main, a book of reference rather than a text-book, it would have been an advantage if the "authorities" for figures and facts had been given in a few more cases and if the results had been presented a little more frequently in the graphical form rather than tabulated as columns of figures. Moreover in Part II., that section of the book dealing with the definite physical properties of given alloys, it is not always perfectly clear in what form (*i.e.*, cast, rolled or extruded, etc.) the metal has been tested.

The commercial importance of the various nickel alloys is well stressed and a long chapter of detailed information about them included.

In a book dealing with engineering non-ferrous alloys it is obvious that the various brasses and bronzes will receive the lion's share of the attention. They are of paramount importance, yet it is interesting to note that Dr. Aitchison and Mr. Barclay devote considerable space to the discussion and description of the "light" alloys of aluminium and magnesium. It is evident that the authors are more than vaguely impressed with the engineering potentialities of these alloys.

It can be fairly said that this book does what it sets out to do—it becomes in the hands of the users of non-ferrous metals a book that is likely to be of great value to them. The book is thoroughly well indexed and illustrated. H. J. M.

Gazette.

A meeting of the creditors of the London Builders' and Engineers' Supplies, Limited, will be held on July 17.

THE PETITION for the winding-up of the Redheugh Iron and Steel Company, Limited, will be heard in London on July 17.

DOBSON & BARLOW, LIMITED, are in voluntary liquidation for purposes of reconstruction. Mr. J. Hudson, 10, Acresfield, Bolton, is the liquidator.

THE SHAREHOLDERS of the Dudbridge Iron Works, Limited, have decided to wind up the company voluntarily. Mr. J. S. Dudbridge, Lansdown, Stroud, Glos., has been appointed liquidator.

THE ELECTRICAL ENGINEERING AND EQUIPMENT COMPANY, LIMITED, are being wound up voluntarily Mr. R. Kettle, of Messrs. Deloitte, Plender, Griffiths & Company, 5, London Wall Buildings, London, E.C., has been appointed liquidator.

THE PARTNERSHIP heretofore subsisting between Messrs. J. A. Higgins and G. F. Higgins, carrying on business as engineers and ironfounders at Regent Engineering Works, Hay Green, Lye, near Stourbridge, under the style of Higgins Brothers, has been dissolved.

THE NAMES of the undermentioned companies have been struck off the Register of Joint Stock Companies, and such companies are dissolved:—Anti-Rust and Metal Deposition Company Limited; Auto Gas Plant Company, Limited; Brasscasters, Limited; Electric Furnaces and Smelters, Limited; Reskett Steel Castings (British), Limited; Howard Smith Engineering Company, Limited; "Le Tenax" Metal Expansion Sockets, Limited; Maggi Foundry and Smelting Company, Limited; Manganese Corporation, Limited; Marine Metal Company, Limited; Metallurgists, Limited; Patrick Engineering Company, Limited; Pullan Engineering Company, Limited; Railway Supply Construction and Engineering Company, Limited; Richard Rostron (Engineers), Limited; Saxon Engineering Company, Limited; Swindon Engineering Works, Limited; Universal Engineering Company, Limited; and the Wellington Steel Works Company, Limited.

Personal.

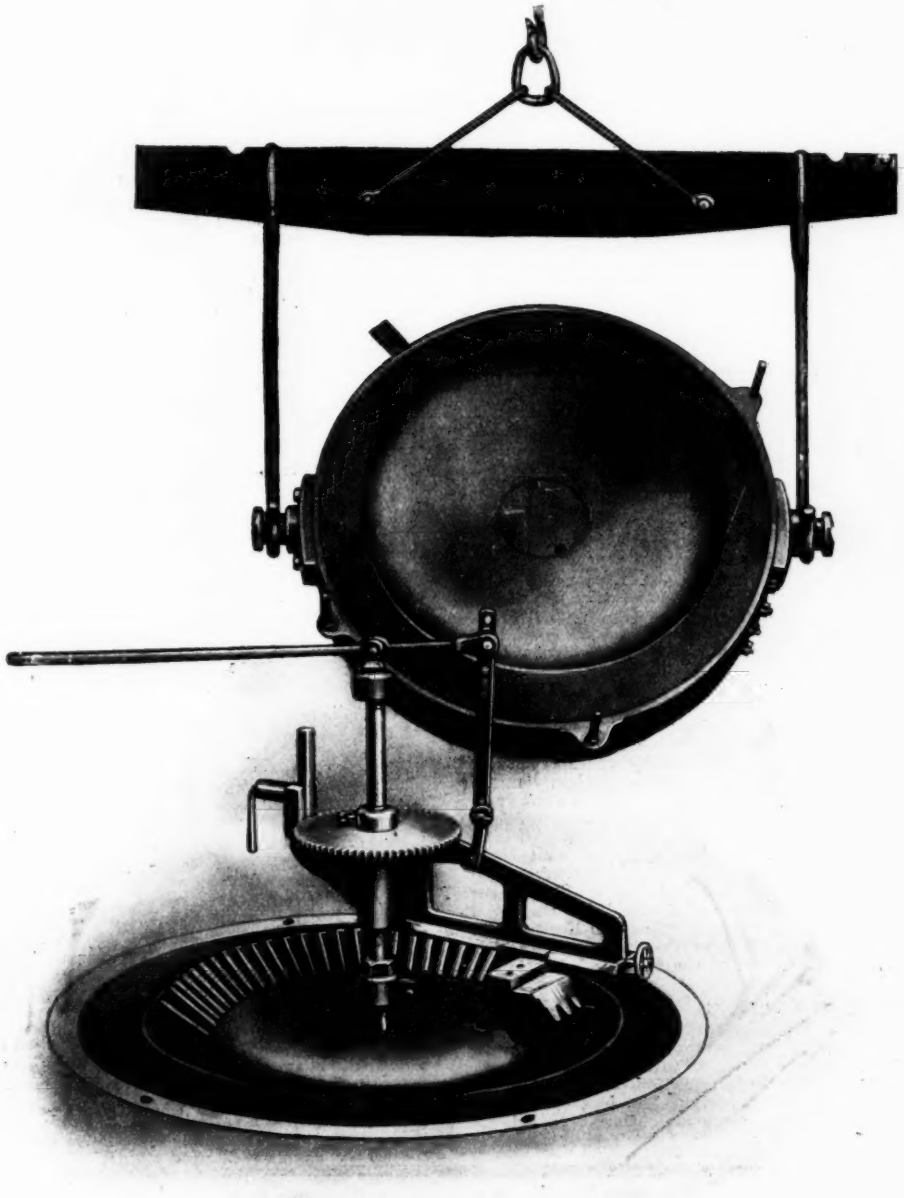
MR. E. P. BENNETT, formerly joint general manager for Simplex Conduits, Limited, Birmingham, has joined Cargills, Limited, Balfour House, 119-125, Finsbury Pavement, London, E.C.2, as engineering manager and buyer.

MR. A. A. TUNGAY has been appointed to take charge of the welding department of Henry Lowe & Sons, Limited, Seminary Street, Royton, Lancs. The firm have taken over the manufacture of the "Tungay" welding plant.

ALD. GEO. GUMMER, chairman of Gummers, Limited, Effingham Brass Works, Rotherham, has had the Honorary Freedom of the County Borough of Rotherham conferred upon him, in recognition of his long public services.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS (MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The position in the pig-iron industry, on the whole, remains practically stationary, and taking the Cleveland market as the standard of comparison, can hardly be regarded as satisfactory, either from the point of view of producer or consumer. According to the official figures, the aggregate production of the home industry in June amounted to 692,900 tons, compared with 714,200 tons in April. The furnaces in blast at the end of the month numbered 222, four having been blown in and five having gone out of blast during the month. The production includes 246,700 tons of hematite, 215,800 tons of basic, 146,500 tons of foundry, and 41,600 tons of forge pig-iron. It should be added, however, that the total for the corresponding period in 1922 was 369,200 tons, showing an expansion of nearly 100 per cent. In the Cleveland market buyers are still holding off, evidently expecting some further impetus in the downward tendency of pig-iron values, although it is difficult to understand how makers can possibly reduce prices to lower levels while fuel costs remain at the excessive figures now quoted. Demand continues on the previously reported diminished scale, the foundries having comparatively little work on hand, and though their stocks must be getting very bare there is nothing in the outlook to induce them to follow other than a hand-to-mouth policy. On the export side it is somewhat singular that amid the general Continental slump German inquiry has been showing signs of revival. Indeed, fair quantities have been sold both of hematite and foundry iron for shipment to Germany recently, but the demand from every other direction is practically at a standstill. In this week's market prices were practically unchanged, makers quoting 107s. 6d. per ton for No. 3 G.M.B., but this figure could be shaded for good quantities. No. 4 foundry and No. 4 forge were both weak, the former at 102s. 6d. and the latter at 100s., while No. 1 was irregular at 115s. per ton.

Business in the Tees-side hematite market must again be reported in an unsatisfactory condition, the home trade having slackened off materially, while the export inquiry, notwithstanding the recent sales to Germany, is extremely stagnant. Values continue to weaken. East Coast mixed numbers are now down to 105s., and this is probably an outside figure. The No. 1 quality is at a premium of 6d. per ton. Similar conditions may be noted in the West Cumberland and Furness area, with Bessemer mixed numbers still nominally quoted at over £5 17s. 6d. per ton, delivered at Glasgow and Sheffield, but the actual price at command is not much above £5 15s. per ton, and there are those who say that there will be little forward buying again until the figure is below £5 5s. per ton.

MANCHESTER.—There is no improvement to note in the business passing in the local market, consumers of pig-iron having now reduced buying to the smallest dimensions essential to almost week-to-week requirements. The basis price for Derbyshire No. 3 is 100s. per ton on trucks at the furnaces. It is possible that lower prices are being accepted for other Midland foundry pig, and for Northamptonshire from 96s. to 97s. 6d. per ton on trucks is quoted; but so far as Manchester consumers are concerned these prices are not better than the price of Derbyshire. Nevertheless, they compete with Derbyshire iron in other districts. Scotch iron is still quoted here at 125s. per ton, delivered, but not much business is being done in it.

THE MIDLANDS.—At last week's quarterly meeting at Birmingham pig-iron producers were very disappointed with their experience. There were no large forward contracts offering, and any business placed was the subject of keen bargaining. Forge iron was a very poor market, but rather better conditions characterised foundry qualities. Some of the Midland producers have been helped by foreign shipments, which have prevented the local markets from becoming overloaded, and have enabled them to maintain a greater degree of firmness than would have been the case had they been dependent entirely on the home trade. There was general complaint from smelters that business is now being done on unremunerative lines, and that it will continue so until coke is easier and demand improves. Quotations current:—Northamptonshire No. 3 foundry, 100s.; Derbyshire No. 3 foundry, 100s., all f.o.t. furnaces.

SCOTLAND.—Glasgow market has virtually closed down for the annual Fair holidays, and consequently business in pig-iron is practically suspended for the remainder of the current month. Judging by the present state of order-books, the outlook is still anything but bright for the re-opening, as work amongst the founders is far from plentiful, and what there is is not remunerative. Prices are again a shade easier, No. 3 foundry Scotch being quoted under £5 10s. f.o.t. furnaces, which is about 15s. fall from the highest price ruling in the spring, but is about 15s. above the current quotation when the rise commenced towards the end of last year.

Finished Iron.

The outlook in the various departments of the finished iron industry can hardly be regarded as hopeful in existing conditions, and with the exception of marked bars, mills are finding it increasingly difficult to avoid periodical stoppages, most of the South Staffordshire plants only working at intermittent intervals. To understand the seriousness of the position it is reported some Black Country firms who own both iron and steel rolling mills have cut out iron altogether, and are only working on steel because they cannot make iron at a profit. And it is doubtful if any maker is producing iron gas strip. It is only when iron tubes are specially required that any is made. Matters are not much better where crown and commoner bars are concerned. In connection with the former we are faced with the inexplicable fact that while one or two firms decline to consider any offers of less than £12 10s. it is reported that others have sold at £11 17s. 6d. to £12, and it is even stated that some material denominated crown iron has been sold at £11 10s. For the time being it is rather a puzzle to know what quotation to give for such iron. Probably the most representative will be about £11 10s. to £12, but everything depends on circumstances. The demand for nut and bolt iron is also very quiet; at any rate, as far as Staffordshire makers are concerned. Nominally their price is £11, while Lancashire makers ask £11 5s., but they are faced with Belgium competition at not more than £9 5s. delivered, and naturally cannot make much headway against it.

Steel.

A considerable decrease in the volume of production is marked in the return of output of steel ingots and castings for June, the figures representing 767,700 tons, as compared with 821,000 tons for May, indicating a progressive decline in demand strikingly opposed to the optimistic views expressed earlier in the year, with a consequent reactionary effect upon the market movements. At Sheffield last week there was no perceptible improvement in conditions, the falling off in the demand for basic billets being very pronounced, due chiefly to underselling by Continental producers, a form of competition which local makers consider will not last long. Soft basic billets can be bought well under £7 10s., and medium and hard are somewhat easier. Acid billets are scarcely inquired for. In the market for alloys, ferro-manganese is the strongest section, chiefly because of the important needs that American users have to satisfy, and makers hold such good order books that the make will probably be maintained until April of next year. Delivery orders are numerous, and large overseas shipments are being made. Values remain unchanged. Business in tinplates continues very quiet, though there are satisfactory shipments of plates on account of old contracts. The price is now at the minimum of 23s. 1½d. f.o.b. Welsh ports, and although there is feeling abroad that the stabilisation scheme will have to be revised, those in authority declare that the scheme will stand until the end of the year.

Scrap.

The depression now prevailing in most branches of the iron and steel trade has had a corresponding effect upon scrap markets everywhere, and it is now extremely difficult to trace evidence of any active buying in the various sections. In Lancashire especially the iron-foundry trade is now very dull, and consumers of scrap do not seem to need any supplies at present. The prices for cast-scrap are irregular, and in the present state of demand it is not easy to say what they are. Probably some qualities can now be bought at 75s. per ton, but for the best kinds of machinery scrap dealers are quoting 85s. per ton in most parts of the country. In Wales rather more than this is paid for special lots. The demand for steel melting scrap is restricted and the Sheffield

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INTERCHANGEABLE

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we can select the right Fan for your purpose because we have a thorough knowledge of Fan applications, acquired by years of experience.

Your requirements are first carefully studied and the Fan then selected that will do the work efficiently through a long life of hard service.

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Mechanical Boiler draught, Ventilation, Blowing Cupolas, Dust Removal, etc.

DAVIDSON & CO., LIMITED,
Sirocco Engineering Works, BELFAST.

consumers are now reluctant to pay even 80s. per ton for it, although basic pig-iron still costs over 110s. per ton. In Wales 82s. 6d. per ton is the buyers' price for melting steel scrap, but most of the works are keeping off the market in the belief that prices will yet be lower. The scarcity of orders at the Scottish foundries is also becoming more aggravated, and it is increasingly difficult to dispose of any classes of cast-iron scrap, heavy machinery metal and scrap chairs run about 90s. to 92s. 6d., and ordinary cast iron 80s. to 82s. 6d. Light metal and furnace firebars are at 67s. 6d.

Metals.

Copper.—Towards the end of the week values of standard copper experienced a set-back, but on the whole the tone of the market has had a fairly steady tendency. Buying, however, has been mostly on a restricted scale, owing to curtailed speculative operations, while the demand on home consumptive account remains comparatively slow. There is really little change in the American position, the surplus stocks there being only about normal, and, in addition, domestic consumption is eminently satisfactory, due to the heavy outlet for finished products. Requirements over the hot season, however, are expected to be curtailed to some extent. The absorbing capacity of the world's markets is obviously kept under restraint by the uneasiness arising from the European political situation. Current quotations:—*Cash*: Thursday, £66; Friday, £65 10s.; Monday, £64 17s. 6d.; Tuesday, £64 12s. 6d.; Wednesday, £65. *Three Months*: Thursday, £66 15s.; Friday, £66 5s.; Monday, £65 12s. 6d.; Tuesday, £65 7s. 6d.; Wednesday, £65 15s.

Tin.—Influenced to a considerable extent by the position in the East, values of standard tin have taken a firmer turn, the market having made a sharp recovery from its recent depressed condition. Towards the close last week, Eastern cables came through at £184 5s. per ton c.i.f., with messages recording the sale of quantities even as high as £186 10s., making the rise at one time as much as £7. The statistical position, as regards stocks in the East, is considered to have improved materially of late, and the tone in London showed considerably more confidence. It is officially reported from Kuala Lumpur that 3,053 tons of tin were exported from the Federated Malay States during the month of June, as compared with 3,108 tons in May and 2,909 tons in the corresponding month of last year. The total export for the six months of the current year is 17,866 tons, against 17,463 tons last year and 16,927 tons in 1921. Current quotations:—*Cash*: Thursday, £183; Friday, £180 15s.; Monday, £178 17s. 6d.; Tuesday, £177 12s. 6d.; Wednesday, £178 7s. 6d. *Three Months*: Thursday, £184; Friday, £182; Monday, £180 2s. 6d.; Tuesday, £178 15s.; Wednesday, £179 12s. 6d.

Spelter.—Notwithstanding a decreased demand for the galvanising trade, business in the market for spelter continues fairly active, while the tendency in the States is distinctly firmer. The Continent was not selling at the current market level, but both Germany and Belgium were desirous of liquidating some metal, if the price were a little more attractive. Current quotations:—*Ordinary*: Thursday, £29; Friday, £28 15s.; Monday, £28 12s. 6d.; Tuesday, £28 16s. 3d.; Wednesday, £29 2s. 6d.

Lead.—Conditions in the market for soft foreign pig are slightly easier, although prices on the whole are firm. As reports reaching this country from America indicate a continuance of good consumption, and that surplus stocks are not sufficiently heavy to erect a seriously depressing influence, it must be assumed that the easier tendency in the United States is largely a reflection of the recent downward movement here. Current quotations:—*Soft foreign (prompt)*: Thursday, £24 12s. 6d.; Friday, £24 5s.; Monday, £24; Tuesday, £24; Wednesday, £24.

FOLLOWING UPON the depression in the iron and steel industry, Alfred Hickman, Limited, Springvale Steelworks, Bilston, have closed down eleven shops and stopped a number of cupolas. The effect of this is to throw about 400 men out of employment for an indefinite period.

THE WAGES PAID by the Ebbw Vale Steel, Iron & Coal Company, Limited, during the past financial year amounted to £1,310,083, compared with £1,336,195 in the previous twelve months. The pig-iron production fell 22,926 tons to 80,188 tons, and the steel output was 39,772 tons lower at 58,457 tons.

Trade Talk.

PLENTY & SON, LIMITED, Newbury, Berks., have joined the Federation of British Industries.

A NUMBER OF MILLS in the Pontypool district have had to be closed down in consequence of the extreme heat.

TWO BLAST FURNACES which were started at Palmers' Works, Jarrow, about three months ago, on hematite, have been closed down again.

ALFRED HERBERT, LIMITED, Coventry, will close their works for the August holidays from Friday evening, August 3, until Monday, August 13.

NORTONS (TIVIDALE), LIMITED, Hecla Works, Tipton, are closing their works for the summer holidays from Saturday, July 28, until Wednesday, August 8.

THE CONTRACT LIST for June of the Turbine Furnace Company, Limited, 238b, Gray's Inn Road, W.C.1, shows treble the business for June, 1922, and double that for June, 1921.

MR. J. F. LACON, iron, steel and metal merchant and engineering and shipbuilding specialist, has removed from 30, Chapel Walks, Liverpool, to 60, Hamilton Square, Birkenhead.

THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION announce a wide programme of research—extending over at least three years—into the question of die-casting alloys. The development and support of die casting in this country as a means of rapid production is of recognised national importance, both for ordinary commercial purposes in the most varied industries and for the manufacture of munitions, etc. The field of investigation has been divided into three sections—(1) brass and bronze alloys; (2) aluminium alloys; (3) low melting point alloys (zinc, tin, lead, etc.). Substantial financial support has been promised by the Department of Scientific and Industrial Research. The British Motor and Allied Industries, the Scientific Instruments and the Electrical and Allied Industries Research Associations have also afforded their support, and it is hoped that the non-ferrous industry as a whole will display active interest in the scheme.

Obituary.

MR. GEO. JONES has died at his residence, Meadowcroft, West Hartlepool. The deceased, who was in his 77th year, was the managing director of William Gray & Company, Limited, the well-known North of England shipbuilders.

MR. THOMAS WILSON, of Thomas Wilson & Sons (Swalwell), Limited, Derwent Brass Works, Swalwell-on-Tyne, brass founders, died at his residence, Canonbee, Strathmore Road, Rowlands Gill, on July 4, in his 73rd year.

Company News.

Greenwood & Batley, Limited.—Dividend, 2½ per cent., making 5 per cent.

Godiva Engineering Company, Limited, 55, Paternoster Row, E.C.4.—Capital £5,000 in £1 shares. Directors: J. M. Hay and W. F. Willson.

Wm Roberts (Tipton), Limited.—Profit, £330; brought forward, £2,902; available, £3,232; dividend on preference shares paid; carry forward, £957.

E. E. Wigzell, Limited, Billiter House, Billiter Street, E.C.—Capital £1,000 in £1 shares. Directors: Elizabeth Wigzell, Miss D. Wigzell, W. J. C. Merryfield. Engineers.

W. & T. Avery, Limited.—Profit, including amount brought in, £100,905; balance dividend, 10 per cent., less tax, making 15 per cent. for year; reserve, £17,368, making £222,535; carried forward, £35,624.

Tenous Steel Company, Limited, Premier Works, 119, Wentworth Street, Sheffield.—Capital £6,000 in £1 shares to adopt an agreement with L. Tingle and W. H. Draper. Directors: L. Tingle and W. H. Draper.

Autolex, Limited, 1, Candahar Road, Battersea, S.W.11.—Capital £6,000 in 5,500 7 per cent. cumulative preference shares of £1 and 10,000 ordinary shares of 1s. each. Directors: E. F. Roydhouse and V. Fransman. Engineers.

New Company Registrations.

In their statistical Report of New Companies, Messrs. Jordan & Sons, Limited, of Chancery Lane, London, W.C.2, state that there have been formed between January 1 and June 30, 203 companies to handle "Iron, Brass, etc.," and 243 as "Engineers." The registered capital of the former is £1,949,750, and of the latter £3,150,757.